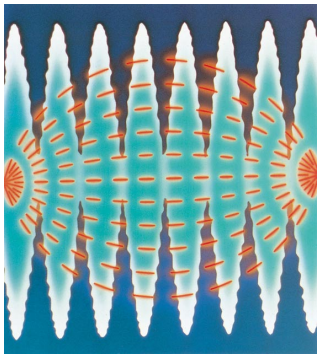
Current Stimulation Devices



Universal-NEUROTON 926
Therapie-NEUROTON 927
STEREODYNATOR 928
SONODYNATOR 934

Service Manual

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Notations

Times New Roman in type size 11	- descriptions and explanations
Arial in type size 10	- functions and keys of the current stimulation device
`Lucida in type size 11 or 10`	- text appears on the display of the current stimulation device

Pictographs

Attention

Warnings which have to be observed by all means !

!! ***Note*** Information that will facilitate your work.

Table of Contents

NOTATIONS AND PICTOGRAPHS 3

TABLE OF CONTENTS 4

1 TASK 7

2 TECHNICAL DATA 8

3 DESCRIPTION OF FUNCTION 9

3.1 Power supply 9

3.2 EX Module 9

3.3 Main board 9
3.3.1 Chip select 9
3.3.2 SRAM 10
3.3.3 V24 interface 10
3.3.4 Power/battery test 10
3.3.5 Speaker control / volume regulation 10
3.3.6 DC/AC transducer 10

3.4 VGA module 10

3.5 Bus board 11

3.6 DSP board 11

3.7 Plug board 11

3.8 Relay board 11

3.9 Display 320 x 240 11

4 SERVICE INSTRUCTIONS 12

4.1 The Service Menu 12
4.1.1 Keyboard 13
4.1.2 Adjustment knobs 14
4.1.3 Display 14
4.1.4 Battery 15
4.1.5 Speaker 16
4.1.6 Interface 16
4.1.7 Vacuum 17
4.1.8 Valve setting 18
4.1.9 Fan 18
4.1.10 Relays 18
4.1.11 Current PA 19
4.1.12 Ultrasound PA 19

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4.1.13 Temperature control 20
4.1.14 Star display (only in case of STEREODYNATOR 928) 20

4.2 Filing of new Firmware - Version 21

5 DISASSEMBLY - ASSEMBLY FLOW DIAGRAM 23

6 SAFETY CHECK 24

6.1 Ground conductor check 24

6.2 Leakage current check 24

7 SPARE PARTS LIST 25

8 CIRCUIT DIAGRAMS 26

APPENDIX: TEST PROTOCOLS

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Summary

Chapter 1 describes the basic characteristics of electrical stimulus devices.

Chapter 2 specifies all relevant technical data of the devices which are necessary for their operation or repair works.

Chapter 3 describes all structural components, their functions, peculiarities, and service instructions. On the circuit boards only those parts are indicated which are important for the function. Components which are not relevant for the understanding of assembly or for service are not mentioned.

Chapter 4 provides service instructions with the help of which you can check the function of the individual components. Furthermore, it lists the error messages and their possible causes.

Chapter 5 describes the individual steps which are necessary to replace certain components.

Chapter 6 refers to safety checks.

Chapter 7 contains a list of the structural components and spare parts with their order numbers.

Chapter 8 contains block diagrams, component plans and the circuit diagrams of the individual components.

The **appendix** contains the test protocols for the safety checks of the devices.

1 Task

The electrical stimulus devices represent a further development of the devices of the 8th generation. All accessories of the 8th series can also be used with the 9th generation in the same manner. A suction application aid as well as an ultrasound module are optionally available according to the device configuration. Depending on the type of the device, the control elements for suction application aid and ultrasound have already been integrated on the keyboard.

Electrical stimulus devices are suitable **in therapy** for

- treatment of paralyses with complete or partial muscular degeneration,
- treatment of atrophies due to inactivity and weakened muscles after longer periods of inactivity,
- Electrical stimulation therapy without electrolytic side effects and only slight muscle fatigue with the aid of a new type of mirror capacity technology.
- Treatment of pain, muscle spasms, functional diseases of the locomotor system such as sports injuries, peripheral circulatory disturbances, influencing the vegetative system with diadynamic currents, ultrastimulation current, micro-stimulus current, TENS- and TENS Burst currents, high-voltage currents and middle frequency currents,
- Muscle toning and detoning,
- Galvanization and Iontophoresis,
- Treatment of incontinence;

and **in diagnostics** depending on the device configuration they are suitable for

- qualitative and quantitative determination of faradic excitability,
- determination of the rheobase, chronaxy and accommodability,
- MF-Test according to Dr. Lange,
- Recording of stimulating strength/stimulating time characteristics (I/T-curves) with defined, measurable and reproducible rectangular and triangle impulses (exponential current),
- Extensive non-invasive electro-diagnostics of peripheral paralyses,
- Neurodiagnostic examinations with galvano-palpations.

In addition to the three-dimensional interference current, **STEREODYNATOR 928** offers the complete selection of single circuit currents for all known therapeutic procedures.

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2 Technical data

Power supply and frequency:	100, 120, 230, 240 V, 48 - 62 Hz	
Current consumption*:	at 120 V: max. 3,3 A at 230 V: max. 1,65 A	
Mains fuse*:	at 120 V: T3,2 A at 230 V: T1,6 A	
Output current:	max. 200 mA	
Output voltage:	max. 200 V	
MPG-device class.	IIb	
Safety class:	I in accordance to IEC 601 / VDE 0750	
Safety degree:	BF in accordance to IEC 601	
Protection degree against ingress of water	BF in accordance to IEC 601	
dimensions*:	max. 15 cm x 41 cm x 48 cm (H x D x W)	
weight*:	max. 17 kg without accessories	
color:	white RAL 9002 and grey RAL 7016	
Display:	LCD backlighted, 320 X 240 dots full graphic	
Buffer batteries:	CR 2032	
Surrounding conditions:	Device operation:	Temperature range +10 °C ... +40 °C Relative humidity 30 ... 75 %
	Transport and storage:	Temperature range +5 °C ... +50 °C Relative humidity < 90 %, not condensing
Current types:	Galv	- Galvanic current
	SMS	- Strong muscle stimulation acc. to Eichhorn
	DF/CP	- Diadynamic currents
	UR	- Ultrastimulation current
	Micro	- Micro-stimulus current
	F1	- Faradic current
	HV	- High voltage
	T/R	- Universal therapy
	Tens	- Transcutaneous electrical nerve stimulation
	Tens Burst	- Trans. electr. Nerve stimulation in impulse groups
	MF I - VII	- Middle frequency currents
	IG 30/50	- Impulse galvanization
	FM	- Frequency modulation
	LP/MF	- Diadynamic currents
	Incontinence	- rectangular current incontinence
	Sedat*	- Interference current 200 Hz
	Myomot*	- Interference current 50 Hz
	Vegetat. Stim. I*	- Interference current 2,5 - 25 Hz
	Vegetat. Stim. II*	- Interference current 10 Hz
	Vegetat. Stim. III*	- Interference current 0,1 - 1 Hz
	Universal*	- Interference current 1 - 200 Hz
Therapeutic ultrasound module: Ultrasound frequency: Ultrasound power: Ultrasound transducer:	Continuous and pulse mode 875 kHz $\pm$ 2 % max. 2,5 W per 1 cm^2 effective surface 1 cm^2 and 4 cm^2 effective surface	
Suction application module: suction: Suction massage frequency:	 At least 150 mbar in maximum position 0 - 60 pulses per minute	

*) dependent on the type of device and whether the device is equipped with the therapeutic ultrasound modules and the suction application modules

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3 Description of function

3.1 Power supply

The device is connected to the main supply via a module which consists of a mains filter and primary fuses. Admissible input voltages are 100 / 120 / 230 / 240 V with a mains frequency of 48 - 62 Hz.

The secondary voltages are generated by a transformer, a rectifier, and a voltage regulator. In addition, the transformer generates the supply voltage for the pump and pump relays by means of an autowinding on the primary.

The power supply supplies the following output voltages:

voltage	max. constant current	use
5 V	5 A	total digital electronic
±15 V	0,4 A	analog supply
+24 V	0,5 A	relay
+24 V	0,5 A	ventilator and solenoid valve
+95 V	200 mA	supply patient current
+215 V	200 mA	supply patient circuit

3.2 EX Module

The EX module includes the microprocessor 80386 EX inclusive chip set, DRAM and Flash-EPROM. The cycle generation is done by a 50 MHz quartz oscillator which is directly connected to the RADISYS chip set R380 EX. The real cycle frequency of 25 MHz is generated in the chip set and made available to the microprocessor. Upon connection of the device or in case of falling below 5V logical supply, the reset chip TL7705 produces a RESET impulse of defined length.

The EX module is the core of a PC compatible computer. In the Flash-PROM, BIOS and DOS are filed in the upper region. The low region serves as a ROM disk. The operating program for the electrical stimulus device is filed on this ROM disk. Upon connecting the device, BIOS executes a check of all components. DOS which is also filed in the upper region will then be started. The ROM disk behaves like a floppy disk. The program described in AUTOEXEC.BAT will be loaded into the dynamic RAM and started. In addition, the microprocessor and the chip set generate I/O signals.

3.3 Main board

3.3.1 Chip select

The chip select signals for the periphery and the static RAM are generated here with the help of two programmable chips.

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3.3.2 SRAM

The static battery buffered RAM of the size 512K x 8 is directly connected to the data bus. It is used as a RAM disk. The settings for the device are filed on the RAM disk.

3.3.3 V24 interface

The microprocessor provides a serial interface with TTL level. This is compatible with the chip 16550. The V-24 level is generated on the bus board through a driver module. For security reasons it is optically separated.

3.3.4 Power/battery test

The voltages supplied by the power unit are distributed to the different pin-and-socket connectors. The lithium battery can be checked per software. The battery is briefly loaded while its voltage is checked. If the voltage remains under a certain level, then the battery should be replaced. If the 5V supply is inadmissibly low, then the supervisory chip MAX691 disconnects the chip select signal for the static RAM in order to avoid undefined write operations.

3.3.5 Speaker control / volume regulation

The RADISYS chip set supplies an output signal for the direct drive of a loudspeaker. This signal can be modified in its volume in 16 steps by 4 digital outputs. The speaker is located on the bus board.

3.3.6 DC/AC transducer

From the 5V supply voltage, this transducer supplies the alternating voltage to operate the tube backlighting of the LCD display.

3.4 VGA module

The display is connected to the VGA module. The contrast voltage of the display can be modified with three digital outputs.

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3.5 Bus board

The bus board distributes the voltages of the power unit to the plug slots for all current and ultrasound power amplifiers. The vacuum unit, the fan for cooling the amplifiers and the pump are driven by a microcontroller. The coding of patient plugs can be read by means of bus drivers.

With the help of the sound chip SAB600/800, a 3-sound-gong is generated on the bus board.

3.6 DSP board

This module generates the various types of stimulation currents. The control of the amplifiers and temperature recording of the heat sinks on each amplifier are evaluated. The DSP module communicates through a dual ported RAM with the EX module.

3.7 Plug board

All patient relays are located on this board. The safety circuit for the patient relay is realized on this module. The plug board connects the stimulation current to the patient plugs. All signals to and from the patient plugs are filtered on this board.

3.8 Relay board

The pump is controlled on this board. The supply voltage is generated as an autowinding from the transformer.

3.9 Display 320 x 240

The display is a ¼ VGA display driven by the VGA module. The backlighting is accomplished through tubes.

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4 Service instructions

4.1 The Service Menu

The software of the device contains a service menu which makes it possible to check parts of the device with regard to their correct function. The usage of the service menu is similar to that of the user menu.

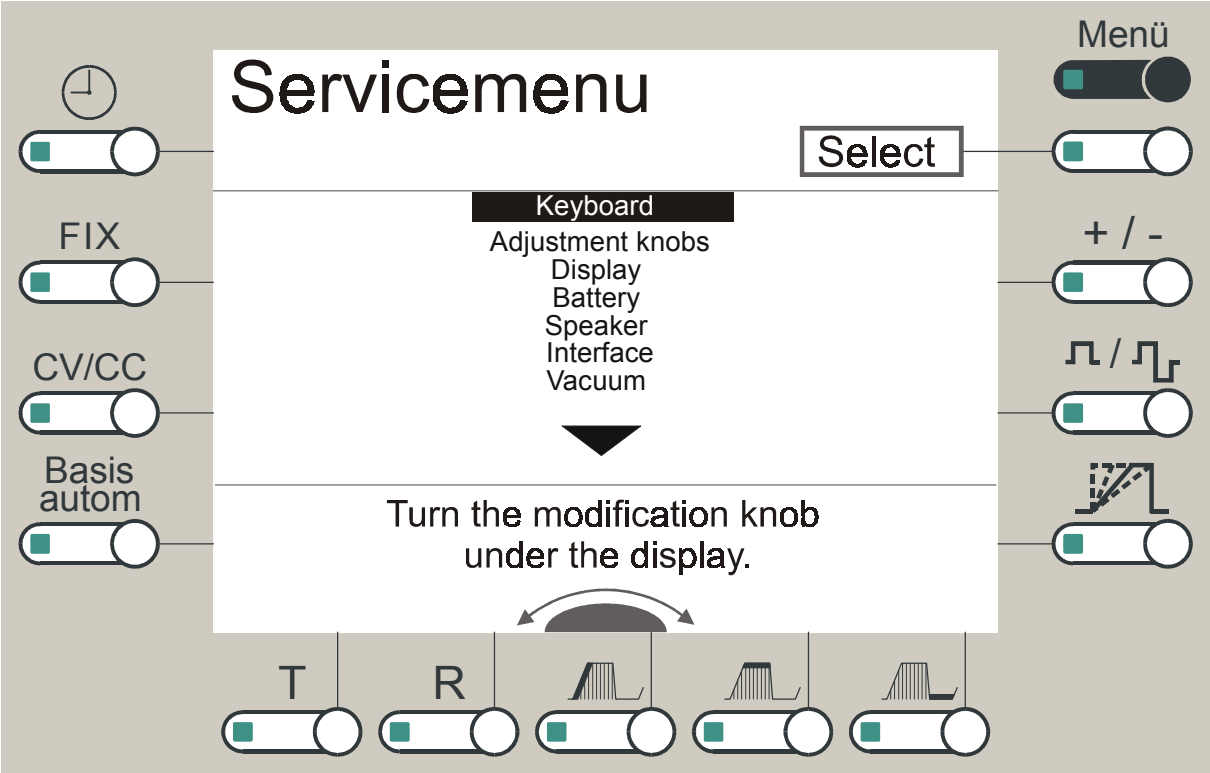

Figure 1: First page of the Service menu

Operating instructions:

1. Simultaneous pressing of the **current type keys CP, UR** and **HV,** and keep them pressed.
2. Switch on the device through the mains switch at the back.
3. When the unit is ready, a sequence of confirmation beeps will be sounded. You can release the **keys CP, UR** and **HV** now and the service menu will be displayed (see above figure).
4. You can move the scroll bar with the **Modification knob**.
5. When the scroll bar has reached the end of the 1st page of service menu, further functions will be offered, see Figure 2.
6. The required service function is selected by pressing the white **Softkey `[select]`**.
7. Data/entries can be modified with the **Modification knob**.
8. Entries are confirmed by pressing the white **Softkey `[select]`**.
9. Most of the service functions are executed either automatically or a detailed user guidance appears on the display of the device.

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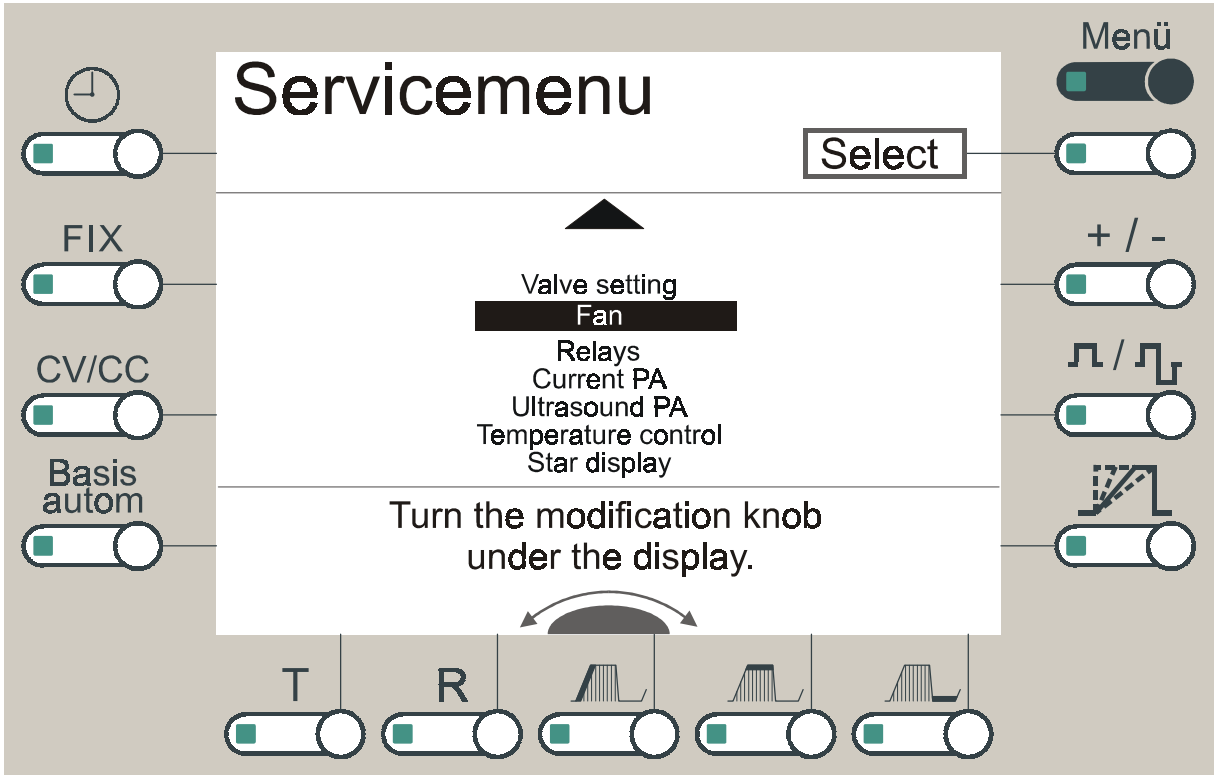

Figure 2: Second page of the service menu

The functions of the service menu are described in the following chapters:

1. Keyboard
2. Adjustment knobs
3. Display
4. Battery
5. Speaker
6. Interface
7. Vacuum
8. Valve setting
9. Fan
10. Relays
11. Current PA
12. ultrasound PA
13. temperature control
14. star display

4.1.1 Keyboard

Call from the service menu:

1. Move the scroll bar to Keyboard.
2. Press the white **Softkey [select]**.

Functional sequence: Proceed as indicated on the display.

1. `Please press key`, when a key has been pressed, then its designation will appear on the display and the corresponding LED will be switched on.
2. When all keys have been pressed once and if everything is OK, press the white **Softkey** `[Escape]`. It returns to the service menu.

OK: all keys have been correctly confirmed.

Failure analysis: One key has not been correctly confirmed.

Source of failure: main board or membrane keyboard
Failure correction: replace the main board or membrane keyboard.

4.1.2 Adjustment knobs

Call from the service menu:

1. Move the scroll bar to `Adjustment knobs`.
2. Press the white **Softkey** `[select]`.

Functional sequence: Proceed as indicated on the display.

1. `Turn modification knob`, turn right, the number on the **„right“** must increase.
2. `Turn modification knob`, turn left, the number on the **„left“** must increase.
3. `Turn intensity knob`, turn right, the number on the **„right“** must increase.
4. `Turn intensity knob`, turn left, the number on the **„left“** must increase.
5. Press the white **Softkey** `[cancel]`. It will return to the service menu.

OK: the above mentioned sequence is progressing correctly.

Failure analysis: Incremental encoders do not function correctly, or loose/weak knobs.

Source of failure: main board or knob/encoder
Failure correction: replace the main board, incremental encoder or knob.

4.1.3 Display

Call from the service menu:

1. Move the scroll bar to `DISPLAY`.
2. Press the white **Softkey** `[select]`.

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Functional sequence:

1. The electrical stimulus device is executing the display test.
2. During the test run it has to be visually checked, if all pixels are displayed correctly.
3. The contrast is switched from minimal to maximal in 14 steps.
4. It returns to the service menu.

OK: all display pixel are visually displayed in a correct way.

Failure analysis:

* Pixels appear faulty.
  Source of error: display
  Failure correction: replace the display.

* The contrast does not change.
  Source of error: VGA module
  Failure correction: replace the VGA module.

4.1.4 Battery

Call from the service menu:

1. Move the scroll bar to `Battery`.
2. Press the white **Softkey `[select]`**.

Functional sequence:

1. The electrical stimulus device is executing the battery test. During the battery test, the battery is briefly loaded in order to determine its capacity. The following message appears:
2. `Battery is being tested ...`
3. Then the message `Battery OK` or `Battery not OK appears`.
4. Press the white **Softkey `[Escape]`**. It returns to the Service menu.

OK: `Battery OK!`

Failure analysis: `Battery not OK`, the battery (order number 007-4-4015) has to be replaced as soon as possible.

Attention

During the replacement of the battery it is necessary that the electrical stimulus device is switched on, in order not to lose the data of the battery buffered RAM disk.

4.1.5 Speaker

Call from the service menu:

1. Move the scroll bar to `Speaker`.
2. Press the white **Softkey [select]**.

Functional sequence:

1. The device is executing the Speaker test.
2. During the test run is has to be acoustically checked, whether the loudspeaker is functioning properly.
   * `Test: sound volume  1-15` (step size: 1)
   * `Test: sound frequency in Hz  300- 1500` (step size: 100)
   * `Test: gong`
3. It returns to the service menu.

OK: the test run sounds acoustically correct.

Failure analysis:

* Volume regulator does not work.
* Speaker does not work.
  Source of failure: main board
  Failure correction: replace the main board.

* Gong does not work.
  Source of failure: bus board
  Failure correction: replace the bus board.

4.1.6 Interface

As a short-circuit plug, a 9 pole Sub-D-socket with the indicated assignment must be used.

Figure 3: short-circuit plug

Call from the service menu:

1. Move the scroll bar to `Interface`.
2. Press the white **Softkey [select]**.
3. Put the short-circuit plug onto the serial interface!

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Functional sequence:

1. The electrical stimulus device is executing the interface test.
2. The message `Interface OK` or `Interface not OK` or `Transmission error` appears.
3. It returns to the service menu.

Possible error messages/sources of failures:

* `Plug the short-circuit plug`: The short-circuit plug has been forgotten; first plug it onto the serial interface and then call the function again.

OK: `interface test OK`.

Failure analysis: `interface test not OK`.

Source of failure: main board or bus board
Failure correction: replace the main board or bus board.

4.1.7 Vacuum

Call from the service menu:

1. Move the scroll bar to `Vacuum`.
2. Press the white **`Softkey [select]`**.

Functional sequence:

1. The electrical stimulus device is executing the vacuum test.
   * `Vacuum intensity: 0 - 100 %` (step size :10 %)
   * `Pulse rate per minute: 60 - 0` (step size: 30)
2. It returns to the service menu.

OK: test is progressing correctly.

Failure analysis:

* Pump does not work.
  Source of failure: bus board, relay board, pump or transformer
  Failure correction: replace the corresponding component.

* There is no suction massage (frequency = 0).
  Source of failure: bus board or vacuum magnet
  Failure correction: replace the bus board or vacuum magnet.

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4.1.8 Valve setting

This function serves for the factory setting of the basic valve characteristic. Do not execute this function because the factory settings are already reset by calling this function only.

The value determined during the factory setting is given in the test protocol of each unit. If the valve value has been (erroneously) overwritten, please restore the basic value according to the units test protocol. The value can be entered with the modification knob after executing this function.

4.1.9 Fan

Call from the service menu:

1. Move the scroll bar to `Fan`.
2. Press the white **Softkey `[select]`**.

Functional sequence:

1. The device is executing the fan test.
2. `Fan step 7, 3, 1`
3. It returns to the service menu.

OK: test is progressing correctly.

Failure analysis: fan does not work or the step does not change.

Source of failure: bus board or fan
Failure correction: replace the bus board or fan.

4.1.10 Relays

Call from the service menu:

1. Move the scroll bar to `Relays`.
2. Press the white **Softkey `[select]`**.

Functional sequence:

1. The electrical stimulus device is executing the relay test.
2. During the test, all relays are tested subsequently. Herewith each relay is switched **on** and **off** five times.
3. It returns to the service menu.

OK: all relays work correctly.

Failure analysis: One relay is faulty.

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* Patient relay is not operating.
  Source of failure: plug board
  Failure correction: replace the plug board.

* Only in case of **STEREODYNATOR 928**: Endogenous/exogenous relay is not operating.
  Source of failure: bus board
  Failure correction: replace the bus board.

4.1.11 Current PA

Call from the service menu:

1. Move the scroll bar to `current PA`.
2. Press the white **Softkey [select]**.

Functional sequence:

1. The current stimulation device is executing the test of the current power amplifier.
2. `Test of current PA active`, then the message `current PA OK` or `current PA Not OK` appears.
3. It returns to the service menu.

OK: `current PA OK`.

Failure analysis: `current PA not OK`. Replace the respective output transformer.

4.1.12 Ultrasound PA

Call from the service menu:

1. Move the scroll bar to `ultrasound PA`.
2. Press the white **Softkey [select]**.

Functional sequence:

1. Connect the ultrasound dummy.
2. Press the **Sono key**.
3. `Coupling voltage: -N`
`Nominal data: 0 +/- 10`
4. Press the **Sono key**.
5. `Head correction: -N`
`Nominal data: 0 +/- 10`
6. Press the **Sono key**.
7. `actual data: -N`
`Nominal data: 0 +/- 10`
8. Press the white **Softkey [Escape]**. It returns to the service menu.

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OK: the values of the ultrasound PA are within the nominal range.

Failure analysis: the values of the ultrasound output transformer are not within the nominal. Replace or calibrate the ultrasound PA.

4.1.13 Temperature control

Call from the service menu:

1. Move the scroll bar to `Temperature control`.
2. Press the white **Softkey `[select]`** .

Functional sequence:

1. The electrical stimulus device is measuring the temperatures of the:

```
transformer:   NN °C
current PA 1:  NN °C
current PA 2:  NN °C     (only for STEREODYNATOR 928)
current PA 3:  NN °C     (only for STEREODYNATOR 928)
ultrasound PA: NN °C
```

2. Press the white **Softkey `[Escape]`**. It returns to the service menu.

OK: the temperature values are within sensible limits (depending on the operating time and the ambient temperature).

Failure analysis:

* The temperature values of the output transformers are not within a sensible range, replace the respective output transformer.

* The transformer temperature is not within a sensible range.
  Source of failure: bus board or transformer
  Failure correction: replace the bus board or transformer.

4.1.14 Star display (only in case of STEREODYNATOR 928)

Call from the service menu:

1. Move the scroll bar to `Star display`.
2. Press the white **Softkey `[select]`** .

Functional sequence:

1. The device is executing the test of the star display.
2. During the test it must visually checked to make sure all LEDs of the star display are being tested correctly.

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3. It returns to the service menu.

OK: all LEDs are displayed visually correct.

Failure analysis: LED is not lit up, replace the star display.

4.2 Filing of new Firmware - Version

The current stimulation device offers the possibility of loading and filing new software through the serial interface. Therefore a PC which is connected to the device through a serial interface is required. In addition, the software `RZFLASH.EXE` needs the file `flprog.exe` and `update.bin` in the same directory.

Procedure:

1. Simultaneously press the **current type keys Micro, T/R** and **Tens Burst** and keep them pressed.
2. Switch on the device through the mains switch at the back.
3. Release the **Key line** only when the device is ready for operation and the tone has sounded.
4. The electrical stimulus device now waits for the transmission of the files.

!! Notice You can exit this status only by switching off and on again!

5. Call-up the **PC** program **RZFLASH,** select an `interface` and set the transmission speed to `19200` Baud.
6. Start transmission, this action can be observed on the display of the **current stimulation device** and on the connected PC monitor.

Attention

The voltage supply of the device should be interrupted by no means during **FLASH** programming! During the operation, you have no possibility of intervention!

Procedure of **FLASH** - programming:

* The service program for the FLASH programming itself is being transmitted.
* The new Firmware is being transmitted (both will be stored on the RAMDISK of the current stimulation device).
* A temporary file is being created which should restart the procedure if unexpected errors appear and the Firmware has not yet been replaced.
* FLASH programming is being started: PROM will now be blockwise deleted and newly programmed
* After the successful programming, the current stimulation device is restarted automatically.

!! Notice briefly check the function of the device.

Attention

If for some reason **FLASH** programming was interrupted, the device has to be restarted !!
If the device does not show any function after the restart, then the Flash-EPROM must be replaced physically!

5 Disassembly - assembly flow diagram

Attention ***before you open the device, disconnect the mains plug!!***

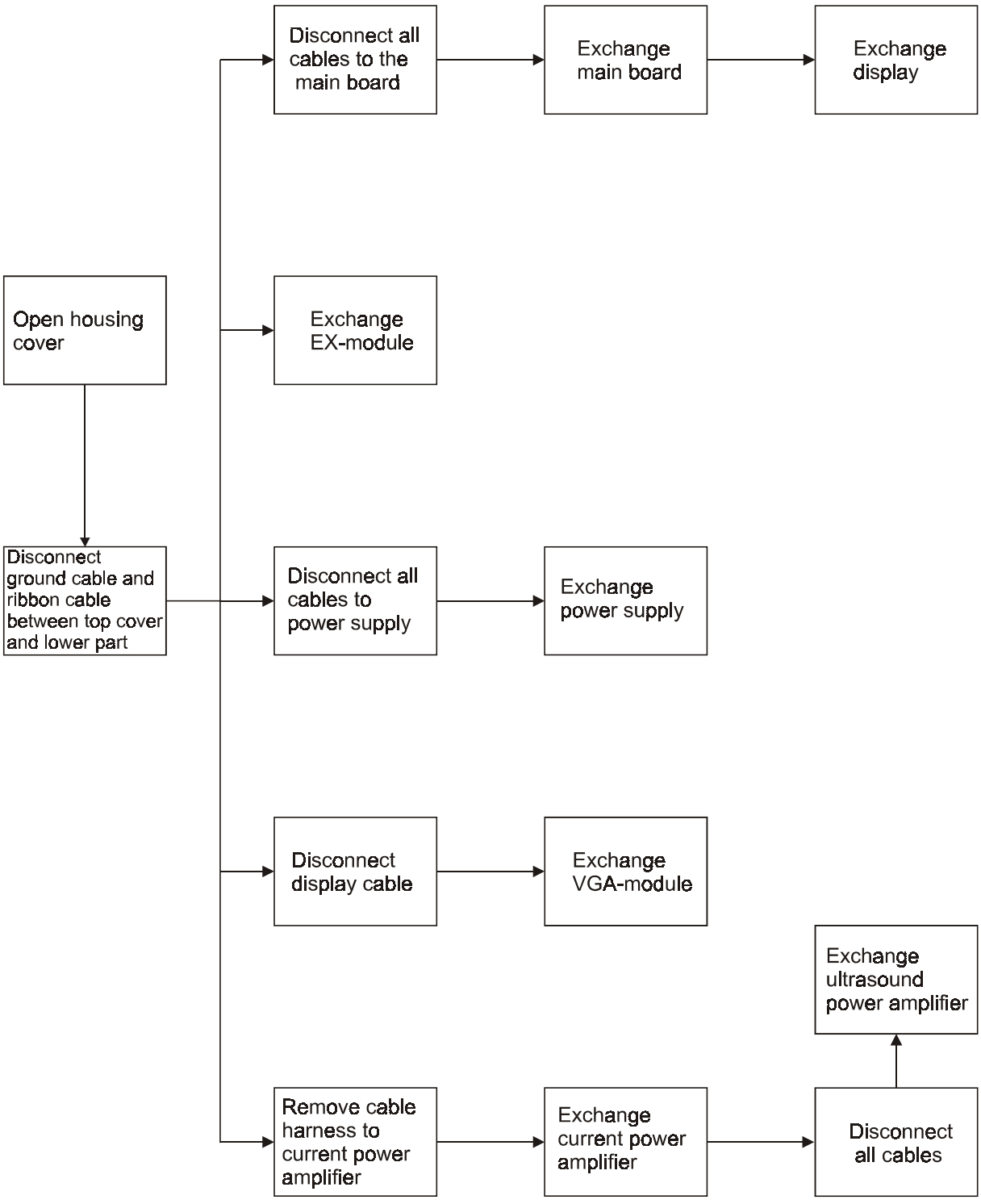
Disconnect all cables to the main board
Exchange main board
Exchange display
Open housing cover
Exchange EX-module
Disconnect ground cable and ribbon cable between top cover and lower part
Disconnect all cables to power supply
Exchange power supply
Disconnect display cable
Exchange VGA-module
Exchange ultrasound power amplifier
Remove cable harness to current power amplifier
Exchange current power amplifier
Disconnect all cables

figure 4: Disassembly – assembly flow diagram

6 Safety check

6.1 Ground conductor check

After assembly of the device, a check of the ground conductor must be performed in accordance with the test protocol (see appendix).

6.2 Leakage current check

If a printed circuit board is being replaced, the leakage current must also be measured; see the test protocol in the appendix.

7 Spare parts list

component:	order number:
Adjustment knob	014-5-0001-E
Battery	007-4-4015-E
Bus board for **Universal-NEUROTON 926**, **Therapie-NEUROTON 927**, **SONODYNATOR 934**	014-1-0014-E
Bus board for **STEREODYNATOR 928**	014-1-0003-E
Current power amplifier	014-1-0026-E
Display	005-4-2020-E
DSP module, complete	014-1-0008-E
EX module	013-1-0004-E
Incremental encoder for modification and intensity control	007-2-7030-E
Main board	014-1-0001-E
Mains filter	007-4-5015-E
Power supply	014-1-0004-E
Pump with mounting racket and filter	014-1-0042-E
Relay printed circuit board	014-1-0020-E
Side part complete, with ultrasound	014-1-0010-E
Side part complete, without ultrasound	014-1-0017-E
Star display	014-3-0001-E
Transformer	014-4-4003-E
Ultrasound dummy	014-0-0005
Ultrasound power amplifier	014-1-0009-E
Vacuum magnet	014-4-0006-E
Fan	014-1-0035-E
VGA module	014-1-0002-E

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8 Circuit diagrams

Figure	Denomination	Version
1	RS-9XX-Block diagram	
2	RS-9XX-Bus component plan	1.1
3	RS-9XX-Bus block diagram	Index 2
4	RS-9XX-Bus amplifier bus	Index 2
5	RS-9XX-Bus output circuit	Index 2
6	RS-9XX-Bus vacuum control	Index 2
7	RS-9XX-Bus DSP module component plan	2.0
8	RS-9XX-DSP module	Index 2
9	RS-9XX-Main board component plan	3.1
10	RS-9XX-Main board block diagram	Index 3
11	RS-9XX-Main board Bus I/O	Index 3
12	RS-9XX-Main board 386 EX module	Index 3
13	RS-9XX-Main board VGA controller	Index 3
14	RS-9XX-Main board S-RAM	Index 3
15	RS-9XX-Main board Front panel I/O	Index 3
16	RS-9XX-Main board Sound	Index 3
17	RS-9XX-Main board Chip select	Index 3
18	RS-9XX-Main board Battery power	Index 3
19	RS-9XX-Main board incremental encoder	Index 3
20	RS-9XX-Power supply component plan	3.0
21	RS-9XX- Power supply	Index 2
22	RS-9XX-Patient plug module component plan	2.0
23	RS-9XX Patient plug module 1/2	Index 2
24	RS-9XX Patient plug module 2/2	Index 2
25	RS-9XX Relay module component plan	
26	RS-9XX Relay module	
27	RS-9XX-Current power amplifier component plan	7.0
28	RS-9XX- Current power amplifier	Index 7
29	RS-9XX-Ultrasound power amplifier component plan	2.0
30	RS-9XX-Ultrasound power amplifier	Index 2
31	RS-9XX-VGA controller component plan	2.0
32	RS-9XX-VGA controller	Index 3

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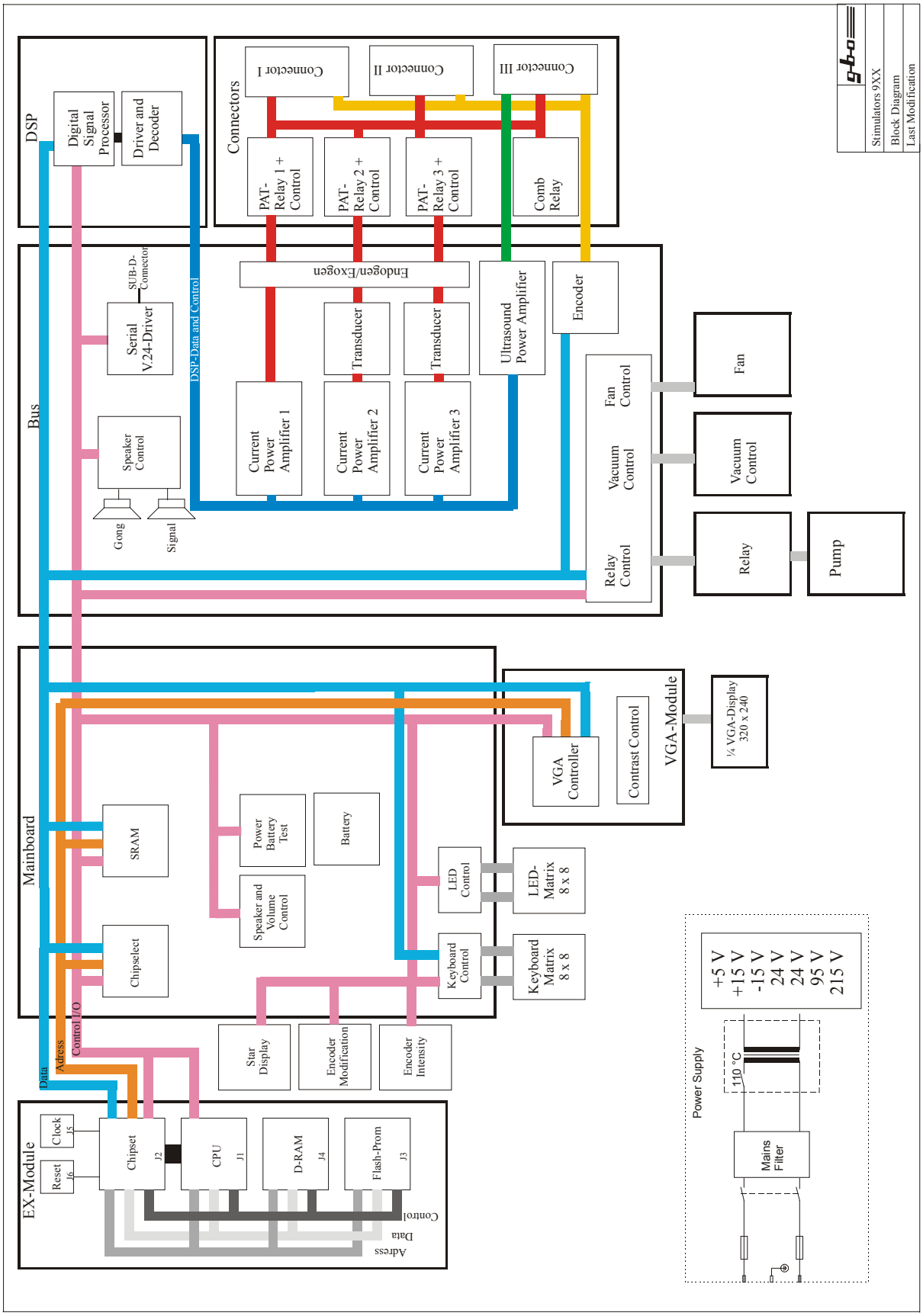
Stimulators 9XX
Block Diagram
Last Modification
DSP
Digital Signal Processor
Driver and Decoder
Connectors
Connector I
Connector II
Connector III
PAT-Relay 1 + Control
PAT-Relay 2 + Control
PAT-Relay 3 + Control
Comb Relay
Bus
SUB-D-Connector
Serial V.24-Driver
DSP-Data and Control
Endogen/Exogen
Transducer
Transducer
Ultrasound Power Amplifier
Encoder
Speaker Control
Gong
Signal
Current Power Amplifier 1
Current Power Amplifier 2
Current Power Amplifier 3
Fan Control
Vacuum Control
Relay Control
Fan
Vacuum Control
Relay
Pump
Mainboard
SRAM
Power Battery Test
Battery
Speaker and Volume Control
Chipselect
LED Control
LED-Matrix 8 x 8
Keyboard Control
Keyboard Matrix 8 x 8
VGA-Module
VGA Controller
Contrast Control
¼ VGA-Display 320 x 240
Star Display
Encoder Modification
Encoder Intensity
Data
Adress
Control I/O
EX-Module
Clock J5
Reset J6
Chipset J2
CPU J1
D-RAM J4
Flash-Prom J3
Control
Data
Adress
Power Supply
+5 V
+15 V
-15 V
24 V
24 V
95 V
215 V
110 °C
Mains Filter

Figure 1

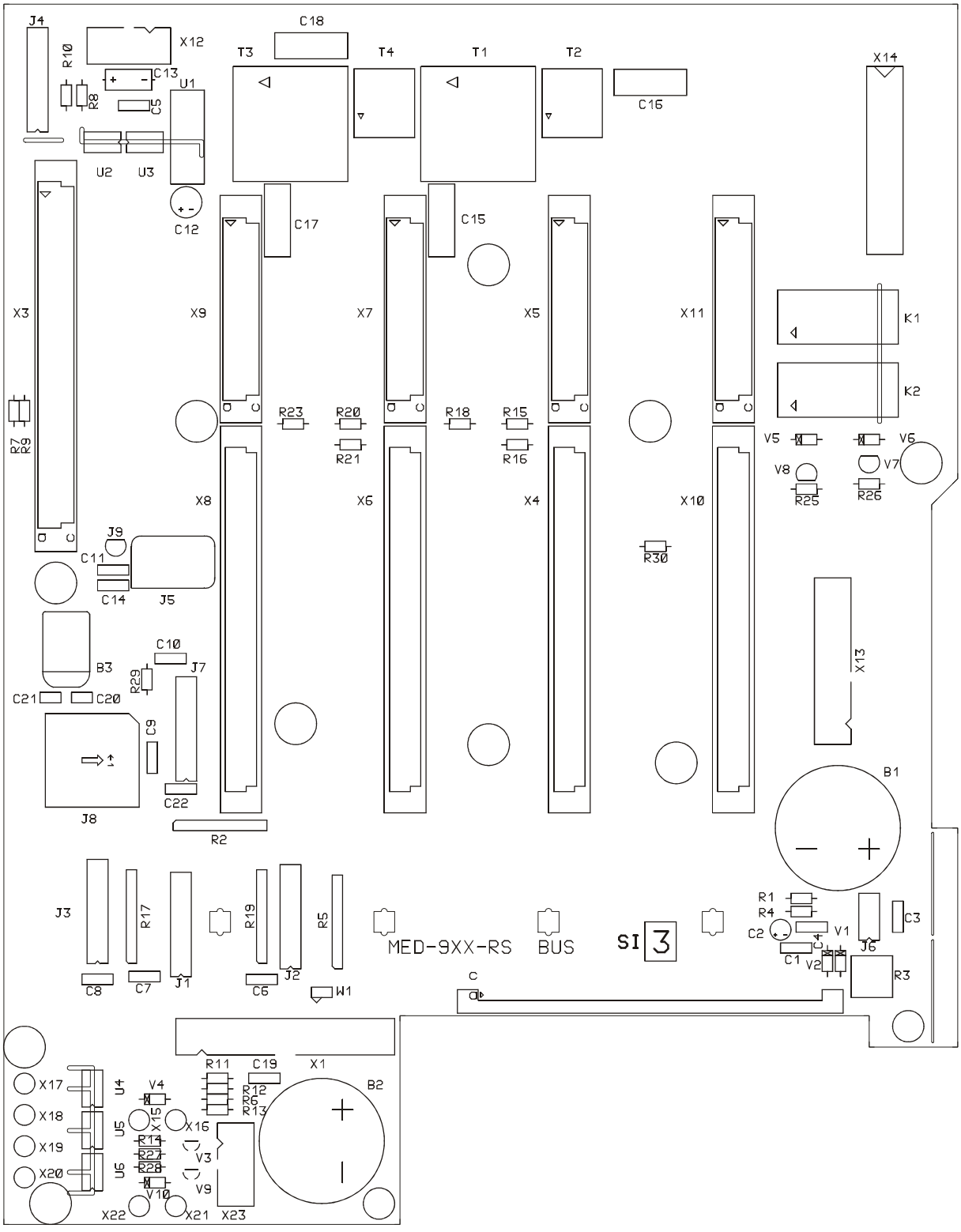
J4
X12
R10
C13
U1
C18
T3
T4
T1
T2
X14
C16
R8
C5
U2
U3
C12
C17
C15
X3
X9
X7
X5
X11
K1
K2
R7
R9
R23
R20
R21
R18
R15
R16
V5
V6
V7
V8
R25
R26
X8
X6
X4
X10
R30
J9
C11
C14
J5
B3
C10
J7
R29
C21
C20
C9
J8
C22
R2
X13
B1
J3
R17
R19
R5
J2
J1
C8
C7
C6
W1
MED-9XX-RS
BUS
SI 3
R1
R4
C2
V1
C3
C1
V2
J6
R3
C
R11
C19
X1
B2
X17
X18
X19
X20
U4
U5
U6
V4
X15
X16
R14
R27
R28
V10
V3
V9
X22
X21
X23
R12
R6
R13

Figure 2

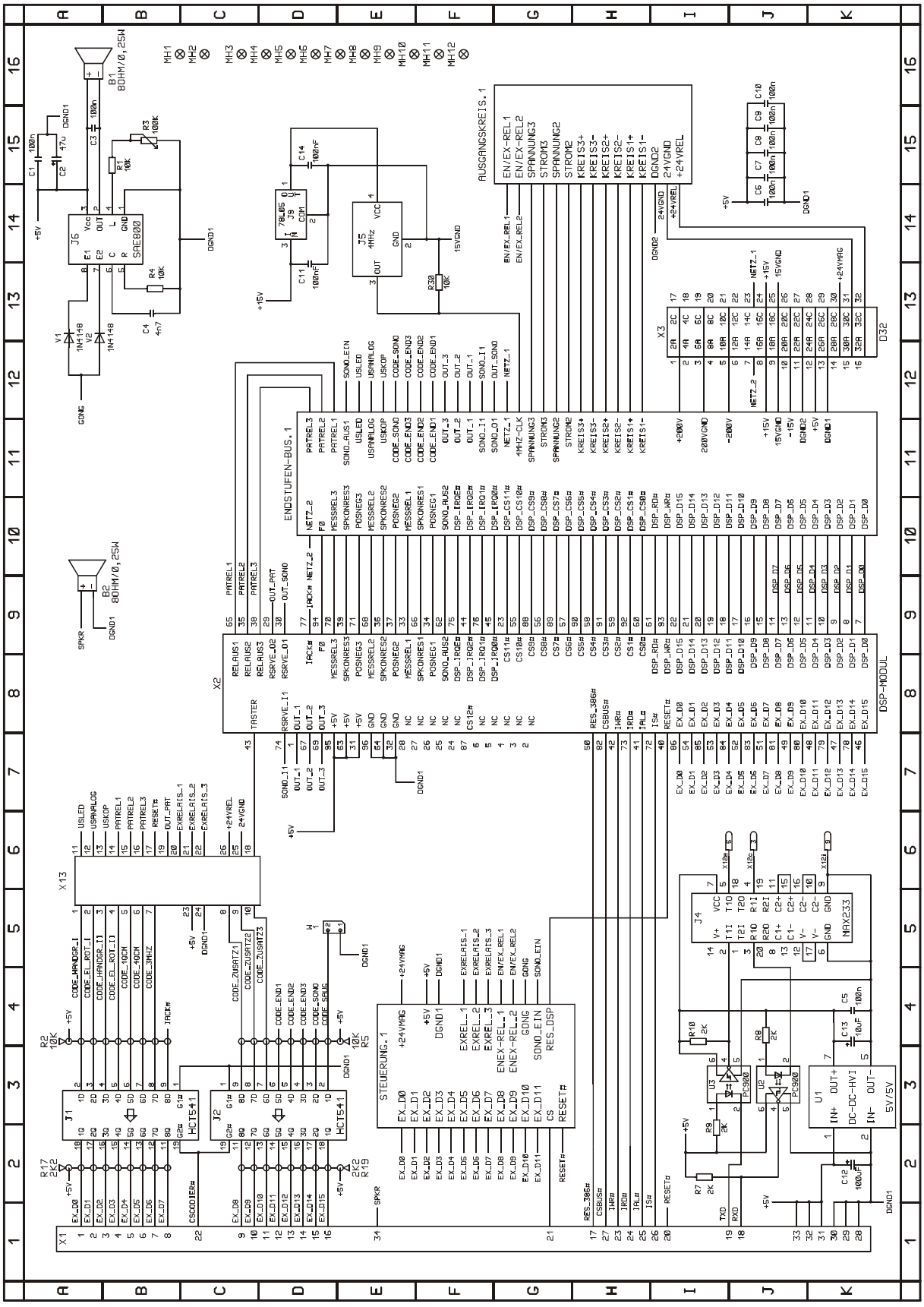

Figure 3

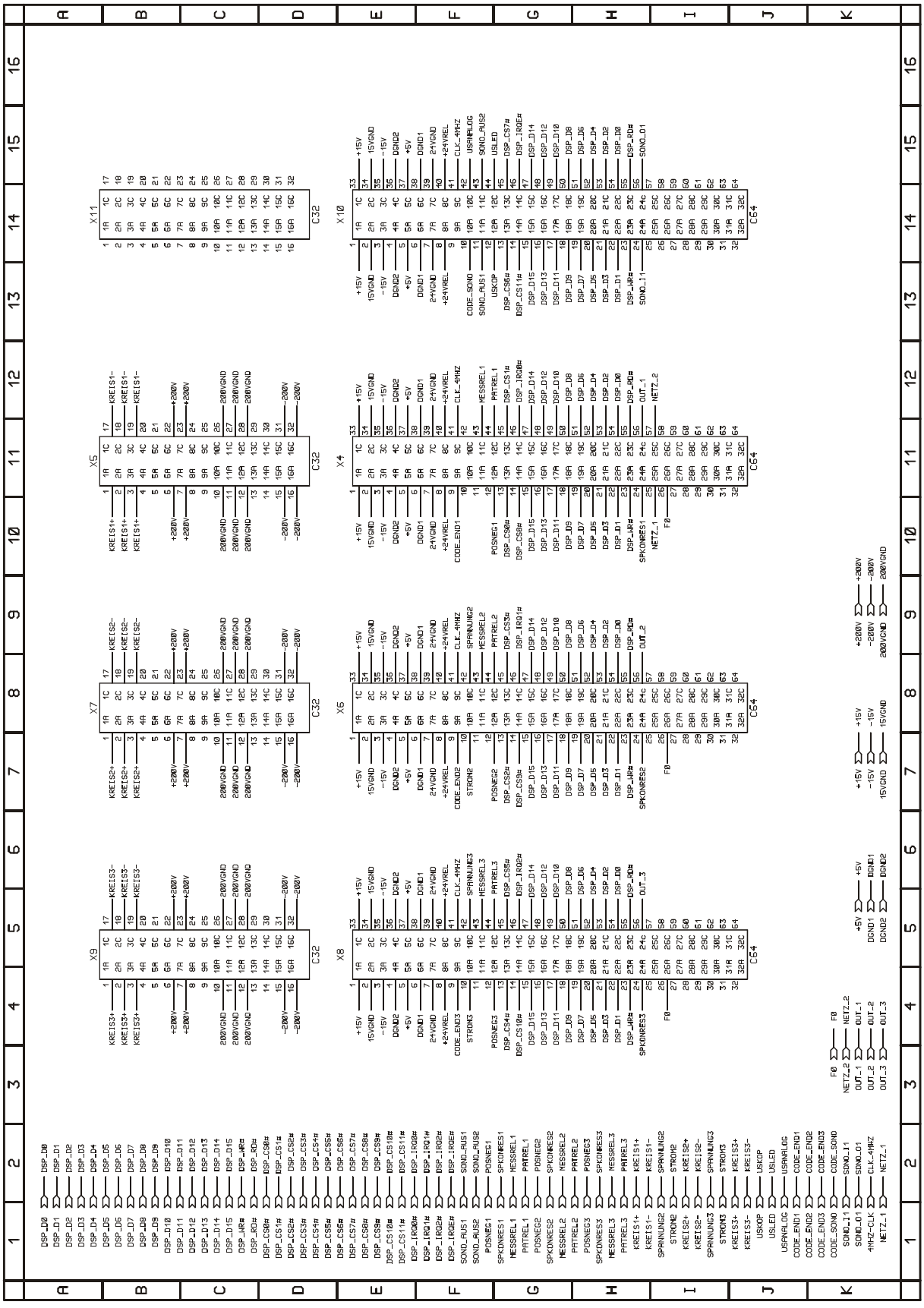

Figure 4

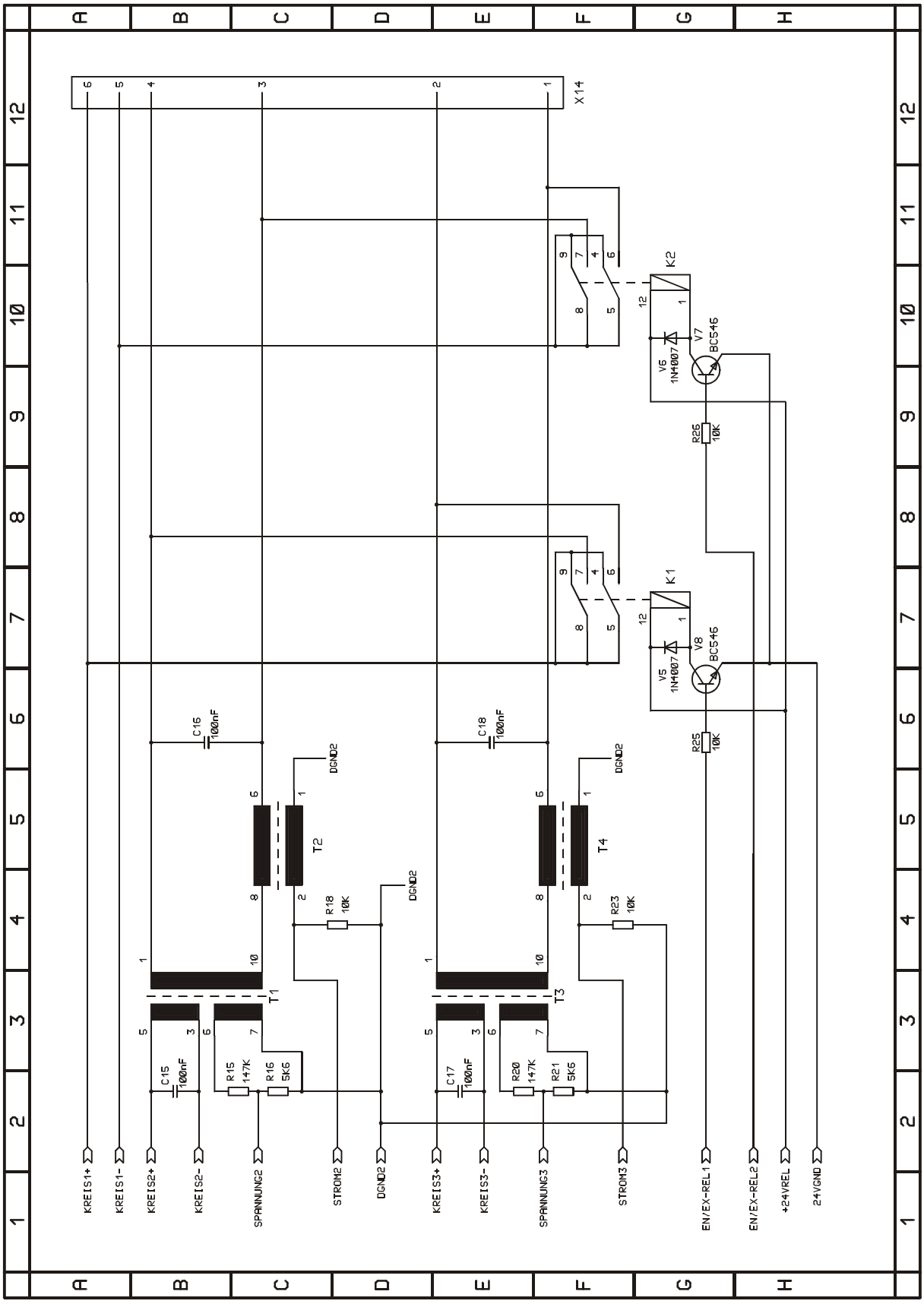
X14
K2
K1
V7
V8
V6
V5
1N4007
BC546
R25
10K
C16
C18
100nF
DGND2
T1
T2
T3
T4
R18
R23
C15
C17
R15
R20
147K
R16
R21
5K6
KREIS1+
KREIS1-
KREIS2+
KREIS2-
SPANNUNG2
STROM2
DGND2
KREIS3+
KREIS3-
SPANNUNG3
STROM3
EN/EX-REL1
EN/EX-REL2
+24VREL
24VGND

Figure 5

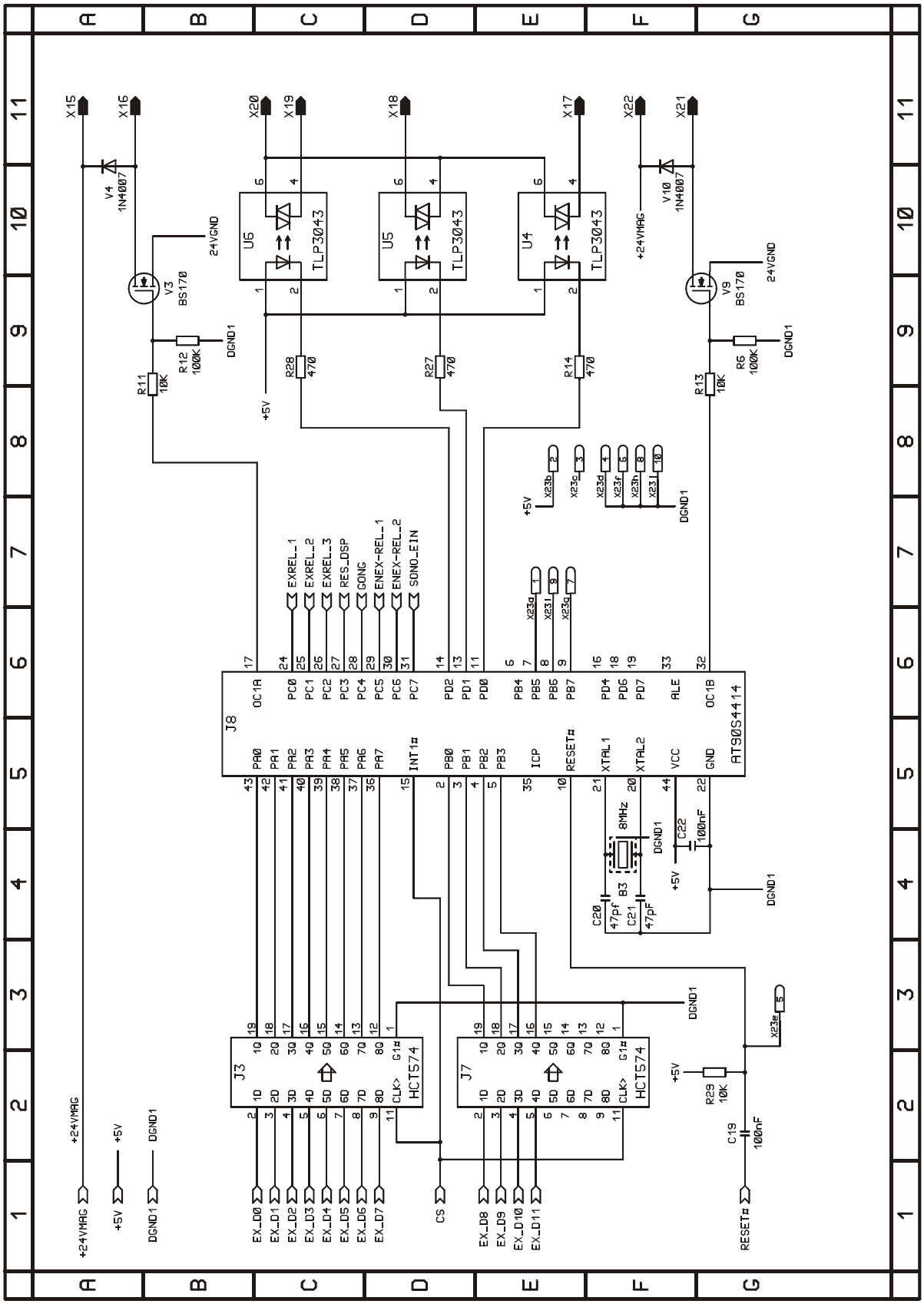
X15
X16
X20
X19
X18
X17
X22
X21
V4 1N4007
V10 1N4007
V3 BS170
V9 BS170
24VGND
+24VMAG
DGND1
+5V
U6 TLP3043
U5 TLP3043
U4 TLP3043
R12 100K
R5 100K
R11 10K
R13 10K
R29 10K
R28 470
R27 470
R14 470
J8 AT90S4414
J3 HCT574
J7 HCT574
EXREL_1
EXREL_2
EXREL_3
RES_DSP
GONG
ENEX-REL_1
ENEX-REL_2
SONO_EIN
8MHz
B3
C20 47pF
C21 47pF
C22 100nF
C19 100nF
EX_D0
EX_D1
EX_D2
EX_D3
EX_D4
EX_D5
EX_D6
EX_D7
EX_D8
EX_D9
EX_D10
EX_D11
CS
RESET¤

Figure 6

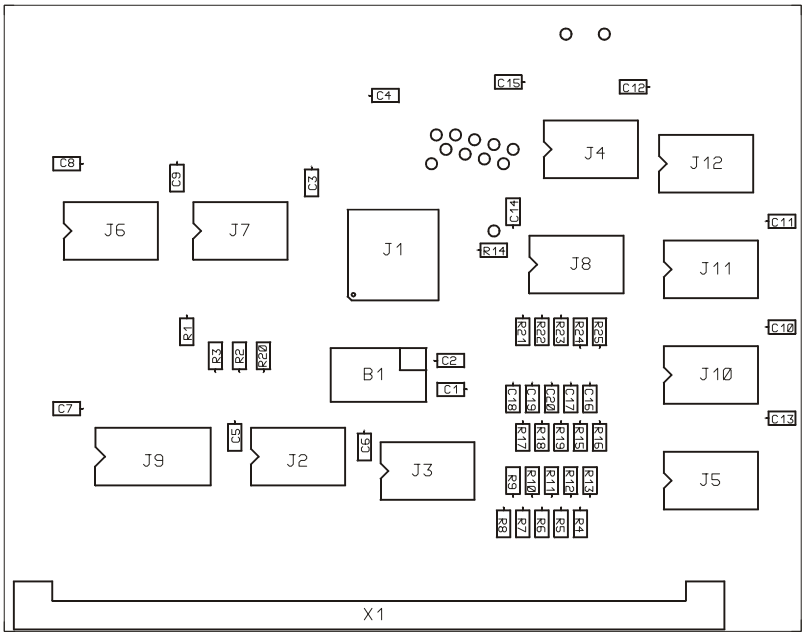
C4
C15
C12
J4
J12
C8
C9
C3
J6
J7
J1
C14
C11
R14
J8
J11
R1
R3
R2
R20
B1
C2
C1
C10
J10
C7
J9
C5
J2
C6
J3
C13
J5
X1

Figure 7

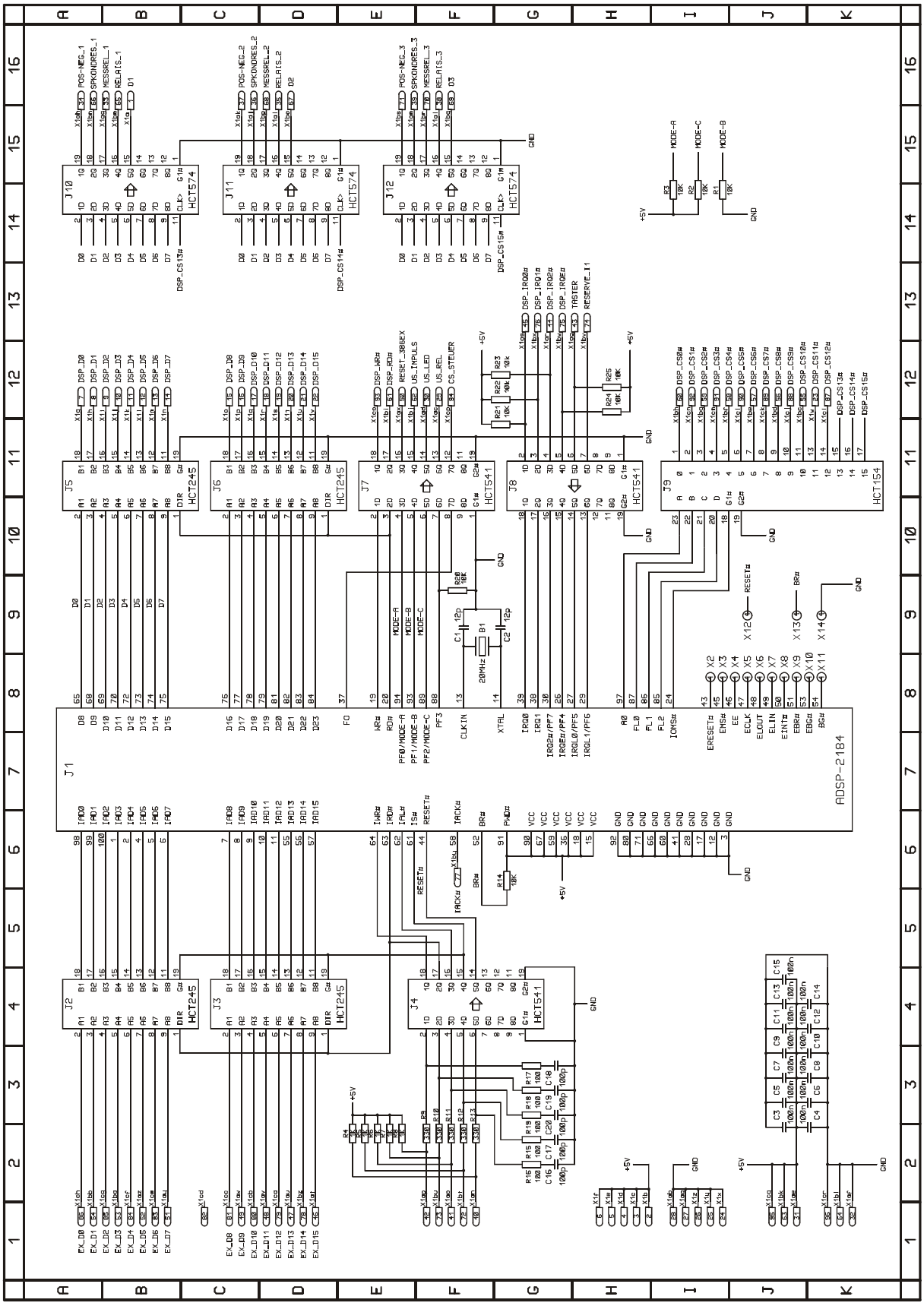

Figure 8

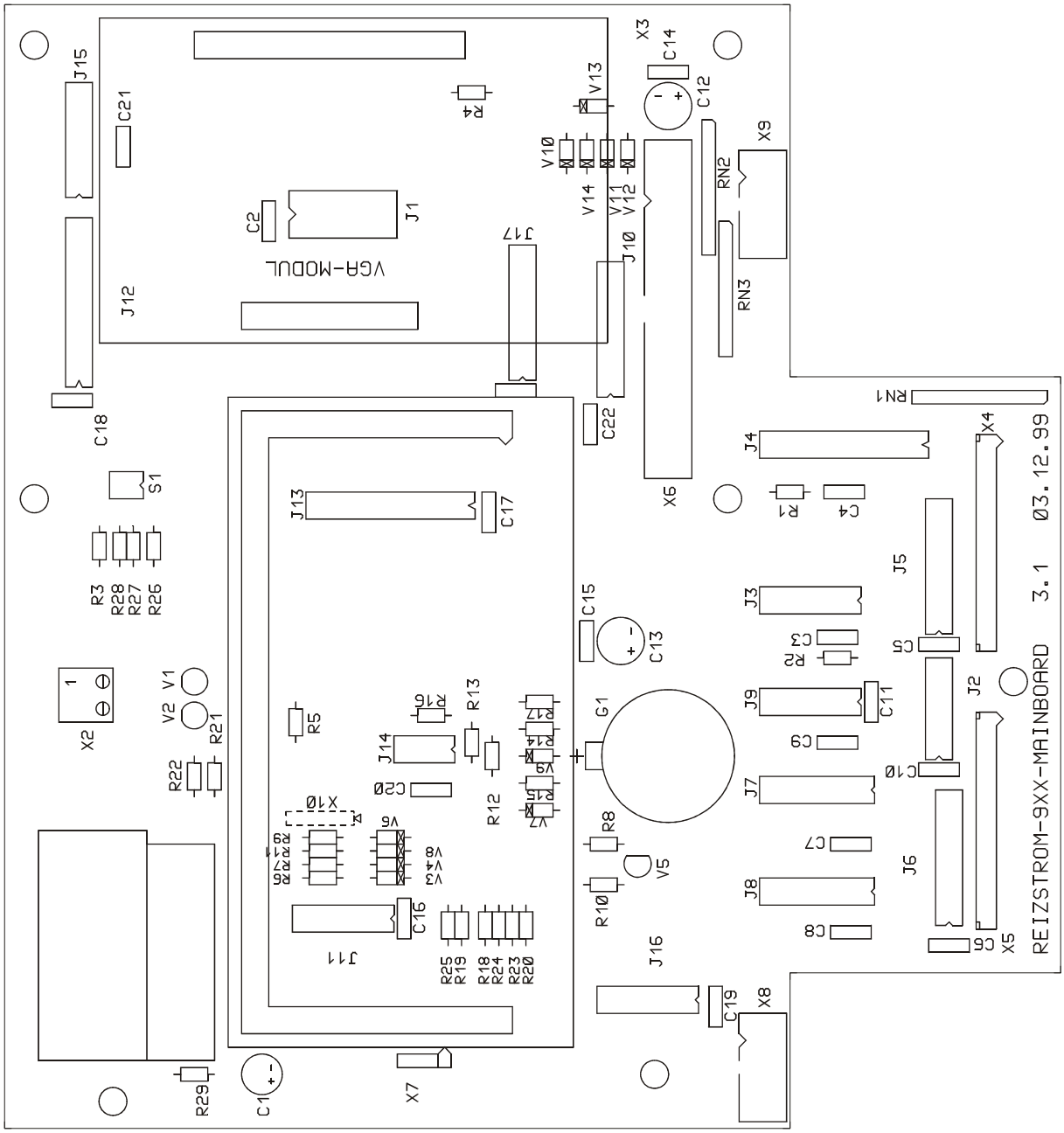

Figure 9

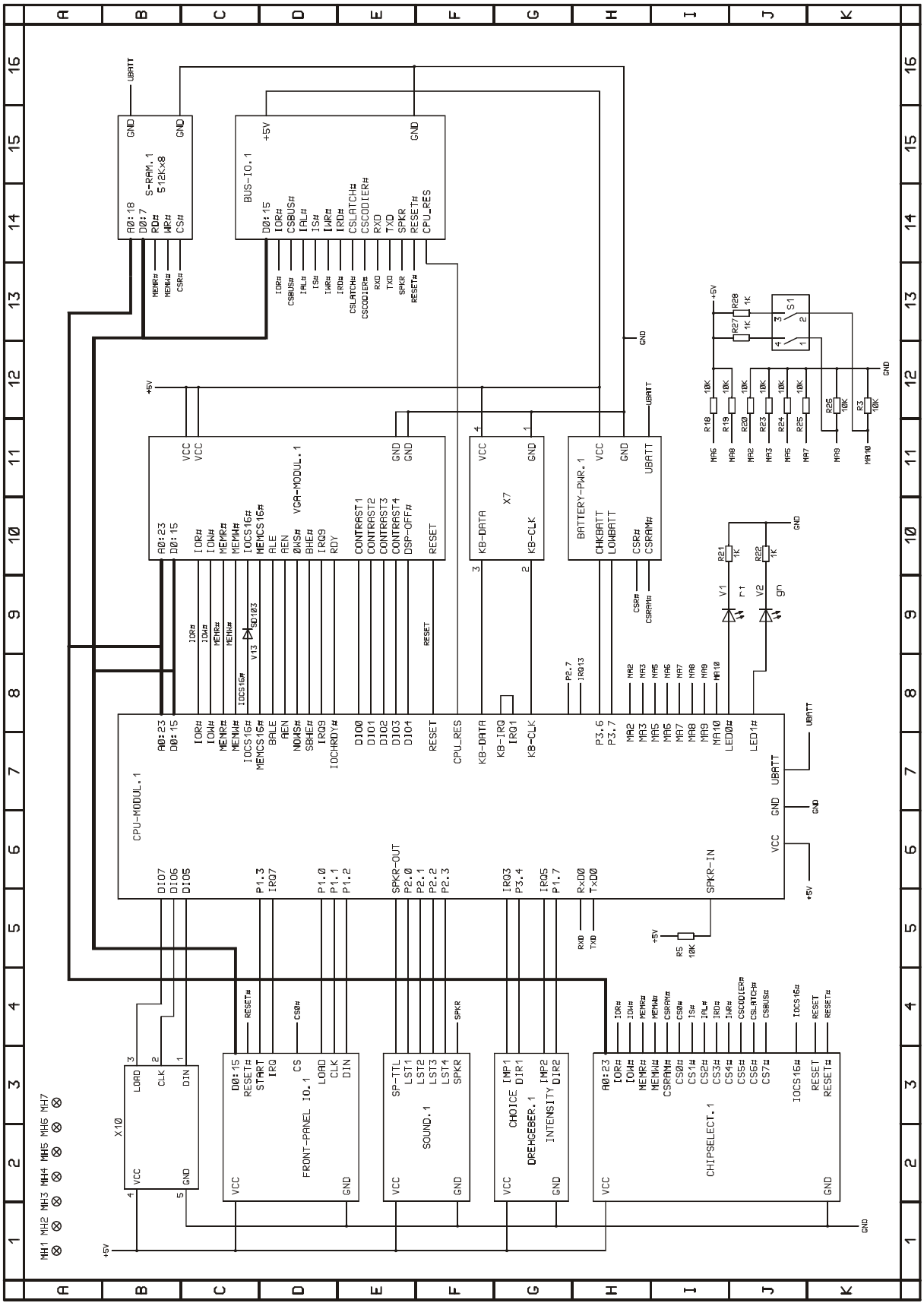
S-RAM.1
512Kx8
BUS-IO.1
VGA-MODUL.1
KB-DATA
KB-CLK
X7
BATTERY-PWR.1
CPU-MODUL.1
FRONT-PANEL IO.1
SOUND.1
CHOICE
DREHGEBER.1
CHIPSELECT.1
S1
X10
UBATT
+5V
GND

Figure 10

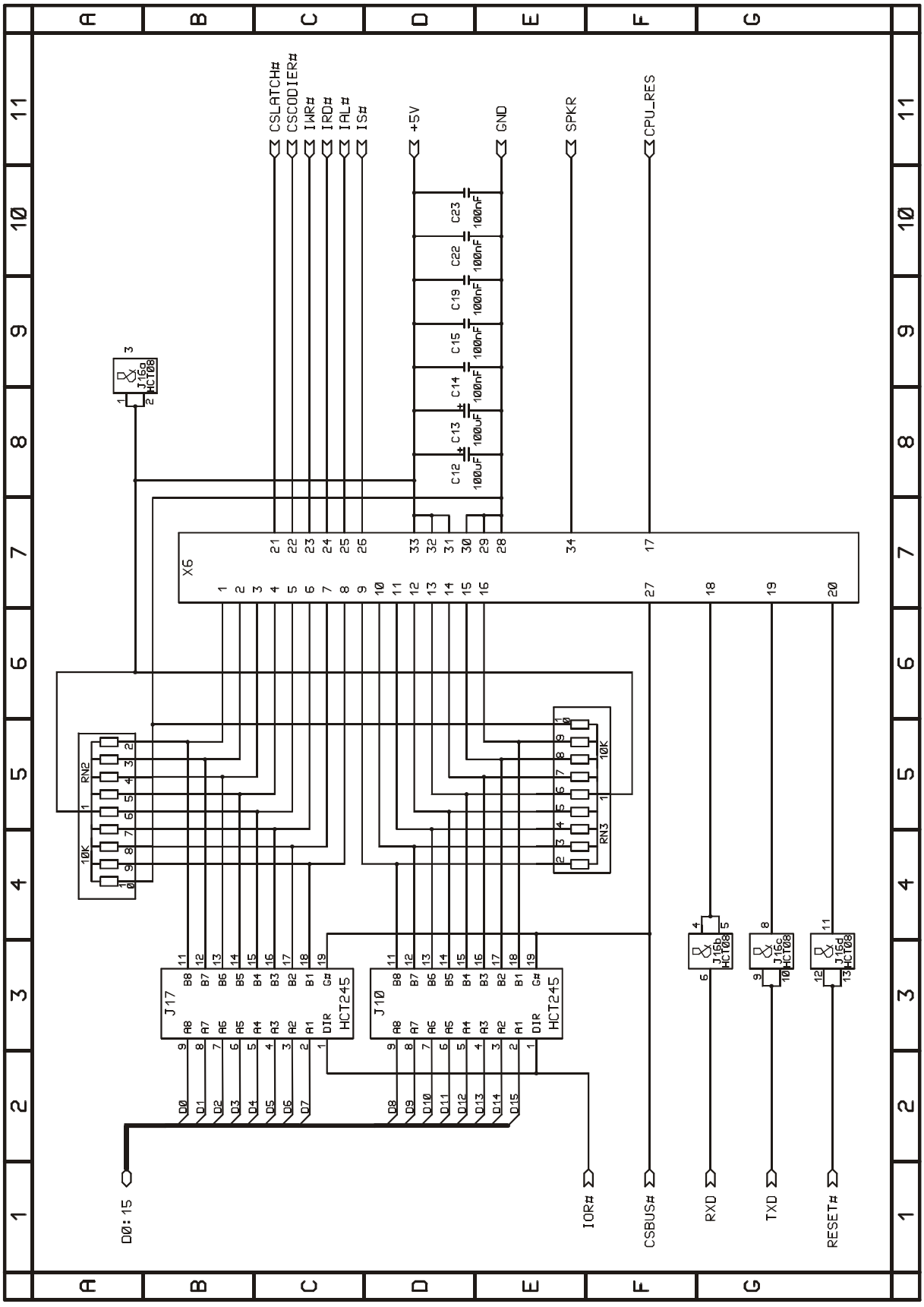
CSLATCH#
CSCODIER#
IWR#
IRD#
IAL#
IS#
+5V
GND
SPKR
CPU_RES
X6
C12 100uF
C13 100uF
C14 100nF
C15 100nF
C19 100nF
C22 100nF
C23 100nF
RN2 10K
RN3 10K
J17 HCT245
J10 HCT245
J16a HCT08
J16b HCT08
J16c HCT08
J16d HCT08
D0:15
IOR#
CSBUS#
RXD
TXD
RESET#

Figure 11

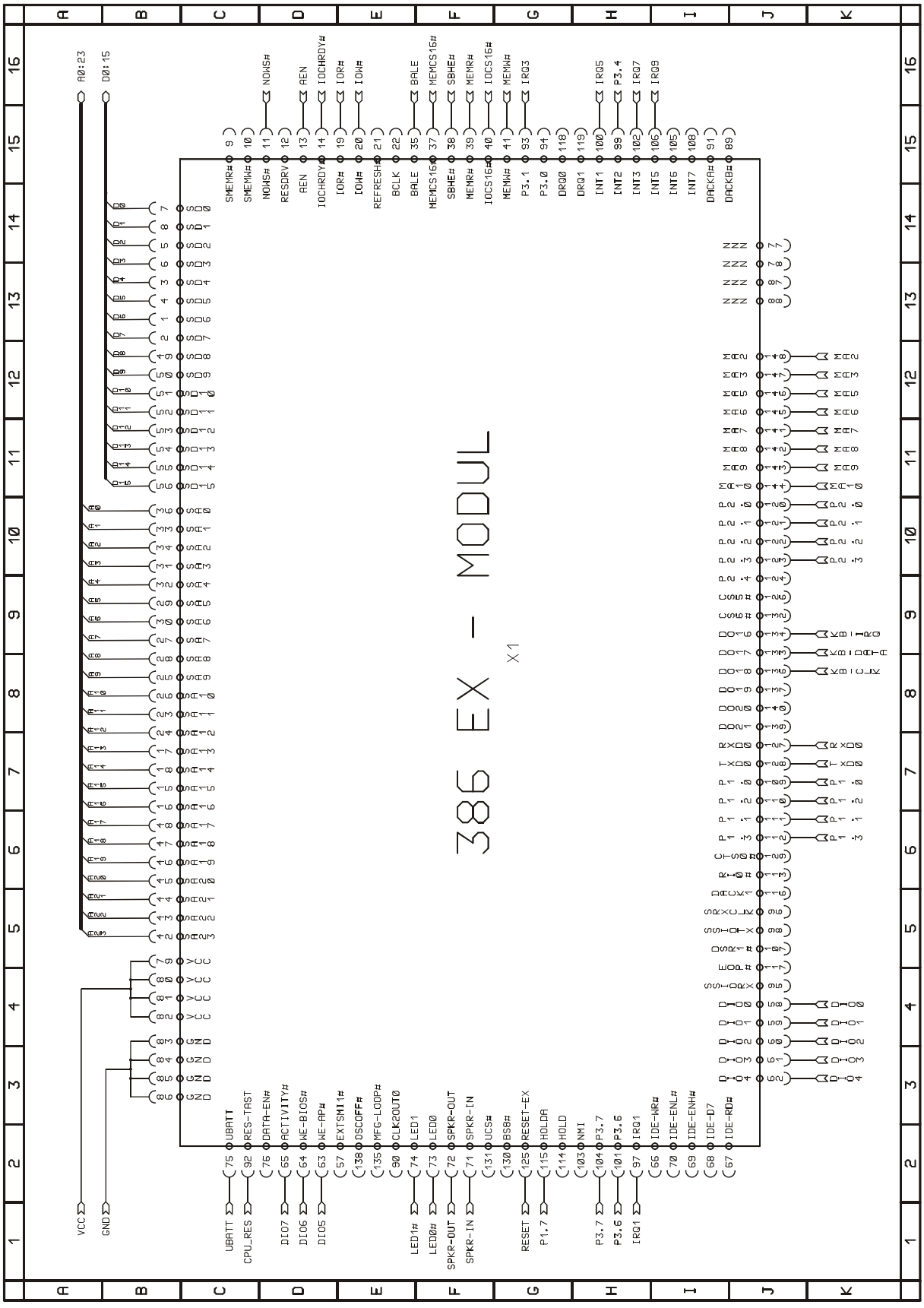

Figure 12

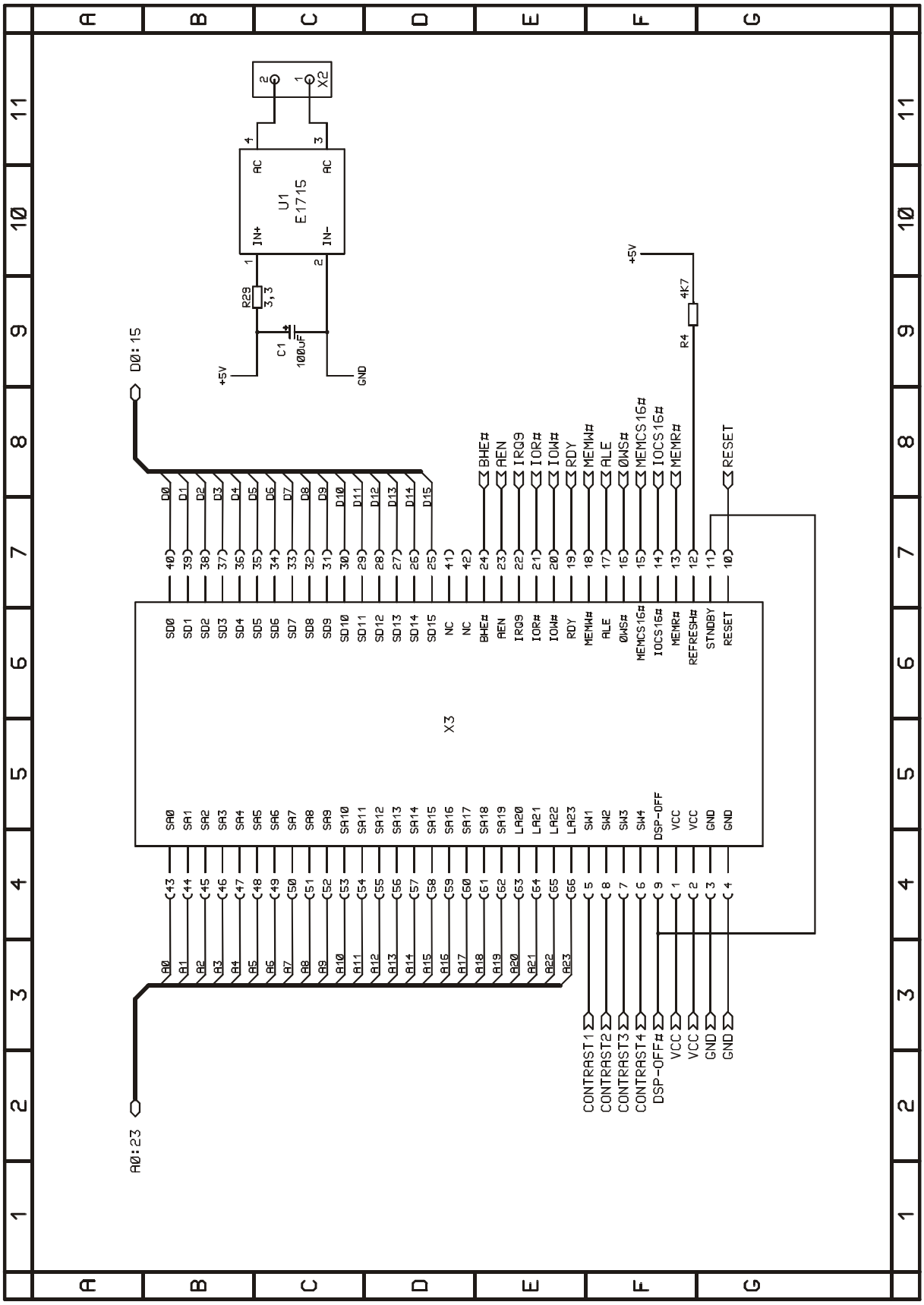
X2
U1
E1715
IN+
IN-
AC
R29
3,3
C1
100UF
+5V
GND
D0:15
A0:23
4K7
R4
X3
SD0
SD1
SD2
SD3
SD4
SD5
SD6
SD7
SD8
SD9
SD10
SD11
SD12
SD13
SD14
SD15
NC
BHE#
AEN
IRQ9
IOR#
IOW#
RDY
MEMW#
ALE
0WS#
MEMCS16#
IOCS16#
MEMR#
REFRESH#
STNDBY
RESET
SA0
SA1
SA2
SA3
SA4
SA5
SA6
SA7
SA8
SA9
SA10
SA11
SA12
SA13
SA14
SA15
SA16
SA17
SA18
SA19
LA20
LA21
LA22
LA23
SW1
SW2
SW3
SW4
DSP-OFF
VCC
GND
CONTRAST1
CONTRAST2
CONTRAST3
CONTRAST4
DSP-OFF#

Figure 13

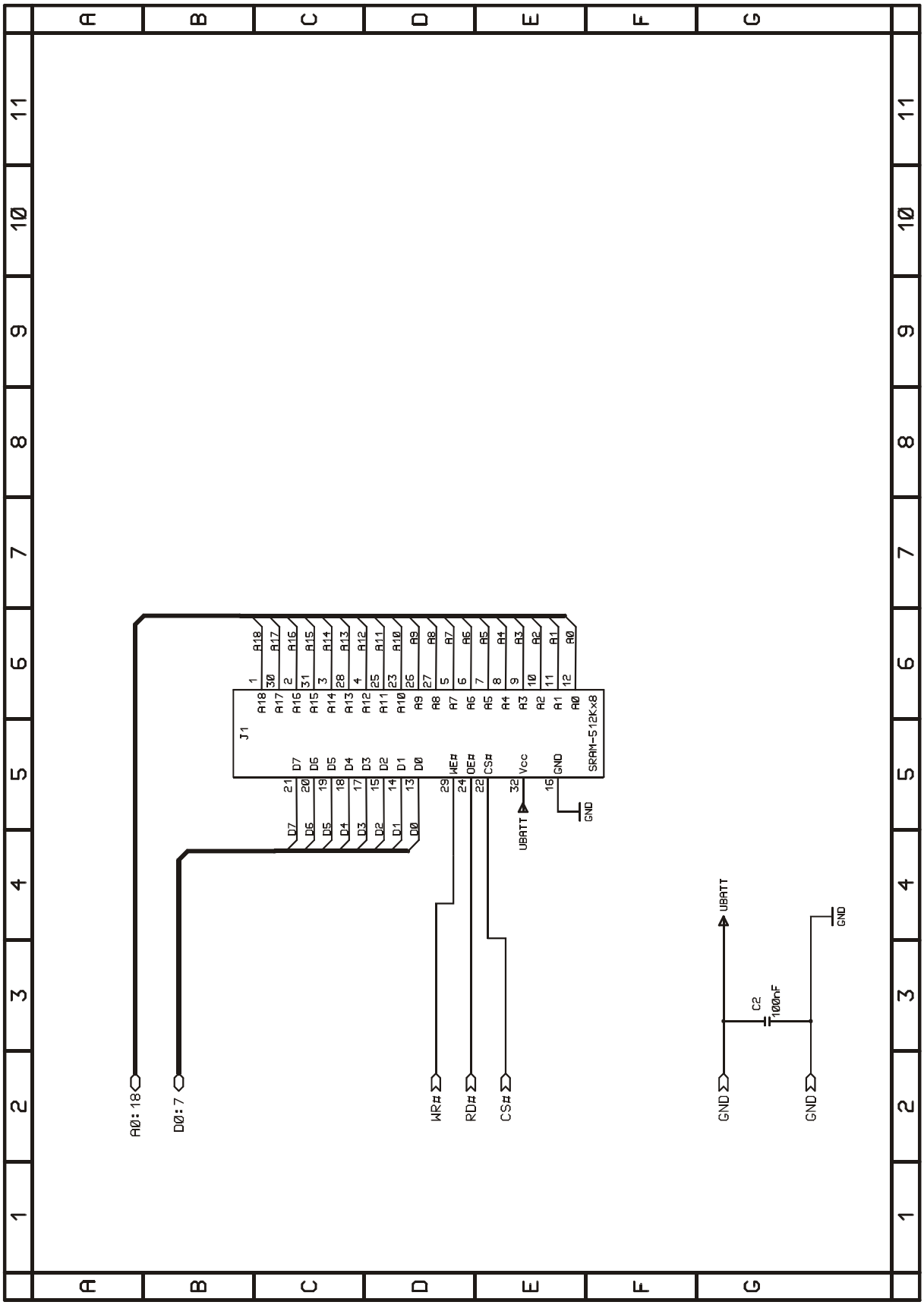
J1
SRAM-512Kx8
A18 A17 A16 A15 A14 A13 A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
D7 D6 D5 D4 D3 D2 D1 D0
WE# OE# CS# Vcc GND
UBATT
GND
A0:18
D0:7
WR#
RD#
CS#
C2
100nF

Figure 14

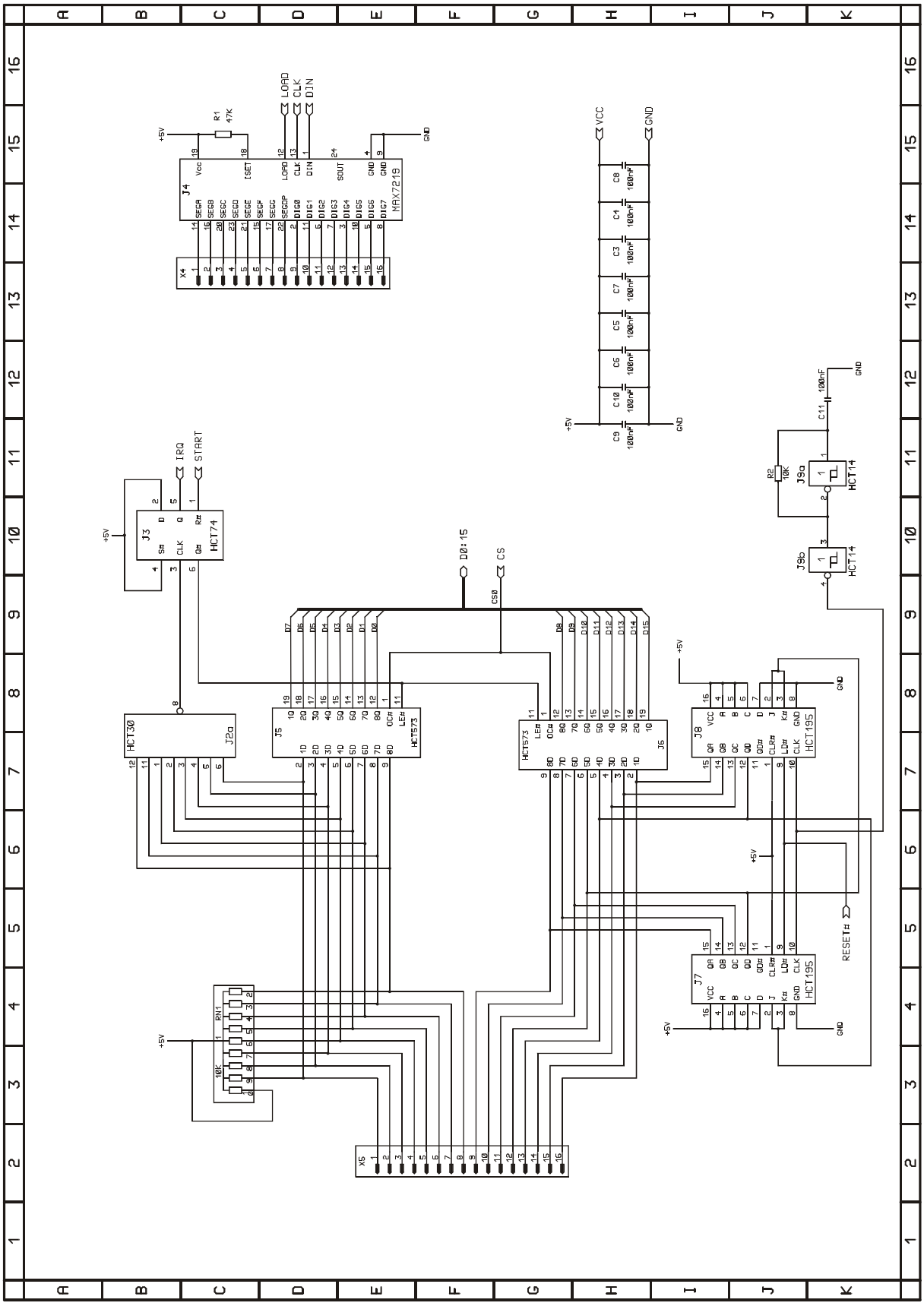
+5V
R1
47K
LOAD
CLK
DIN
GND
J4
MAX7219
X4
VCC
C8
C4
C3
C7
C5
C6
C10
C9
100nF
C11
R2
10K
J9a
J9b
HCT14
IRQ
START
J3
HCT74
D0:15
CS
CS0
HCT30
J2a
J5
HCT573
J6
J8
HCT195
J7
RESET#
RN1
10K
X5

Figure 15

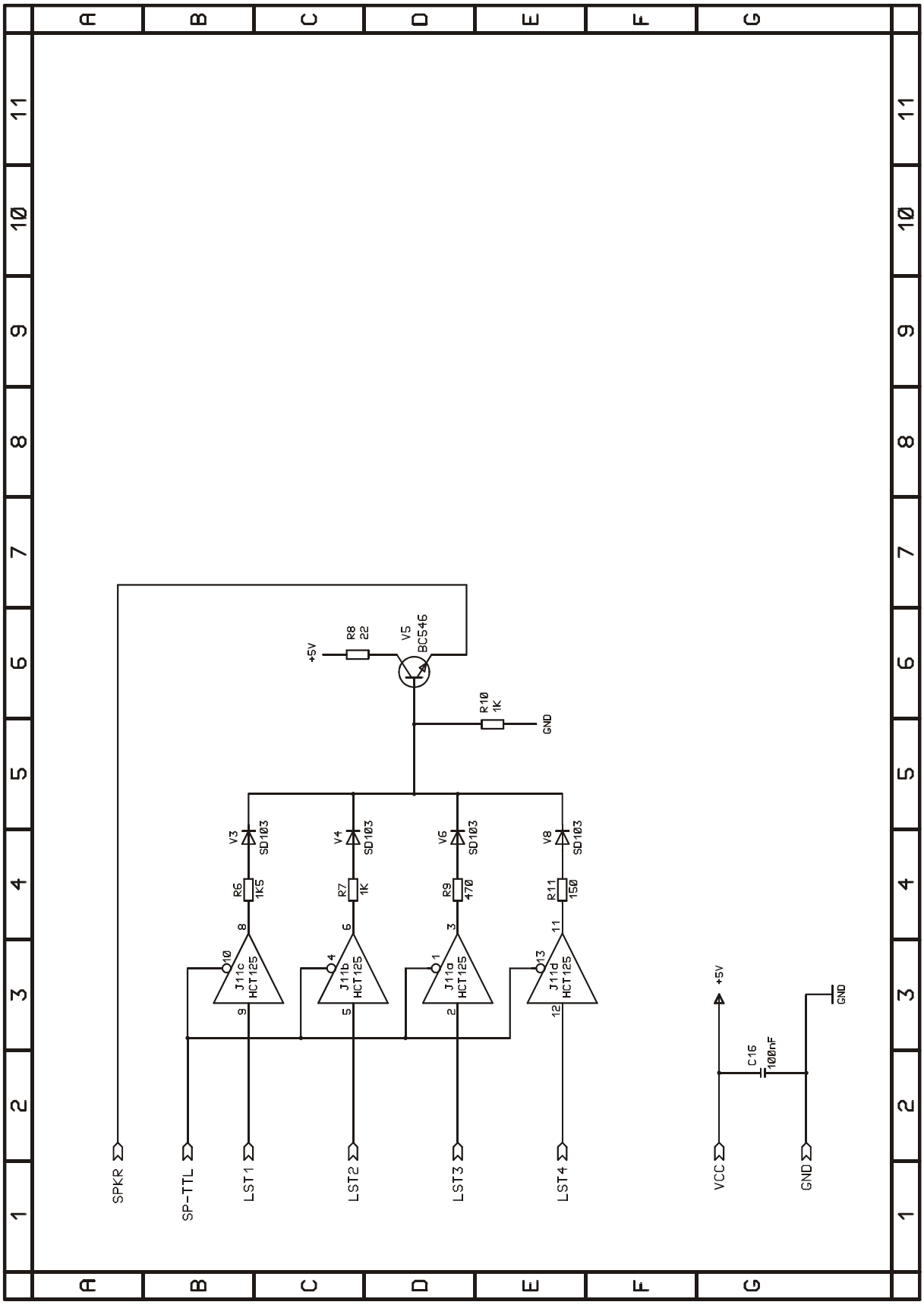
A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
9
10
11
+5V
R8
22
V5
BC546
R10
1K
GND
V3
SD103
V4
SD103
V6
SD103
V8
SD103
R5
1K5
R7
1K
R9
470
R11
150
J11c
HCT125
J11b
HCT125
J11a
HCT125
J11d
HCT125
C16
100nF
SPKR
SP-TTL
LST1
LST2
LST3
LST4
VCC
GND

Figure 16

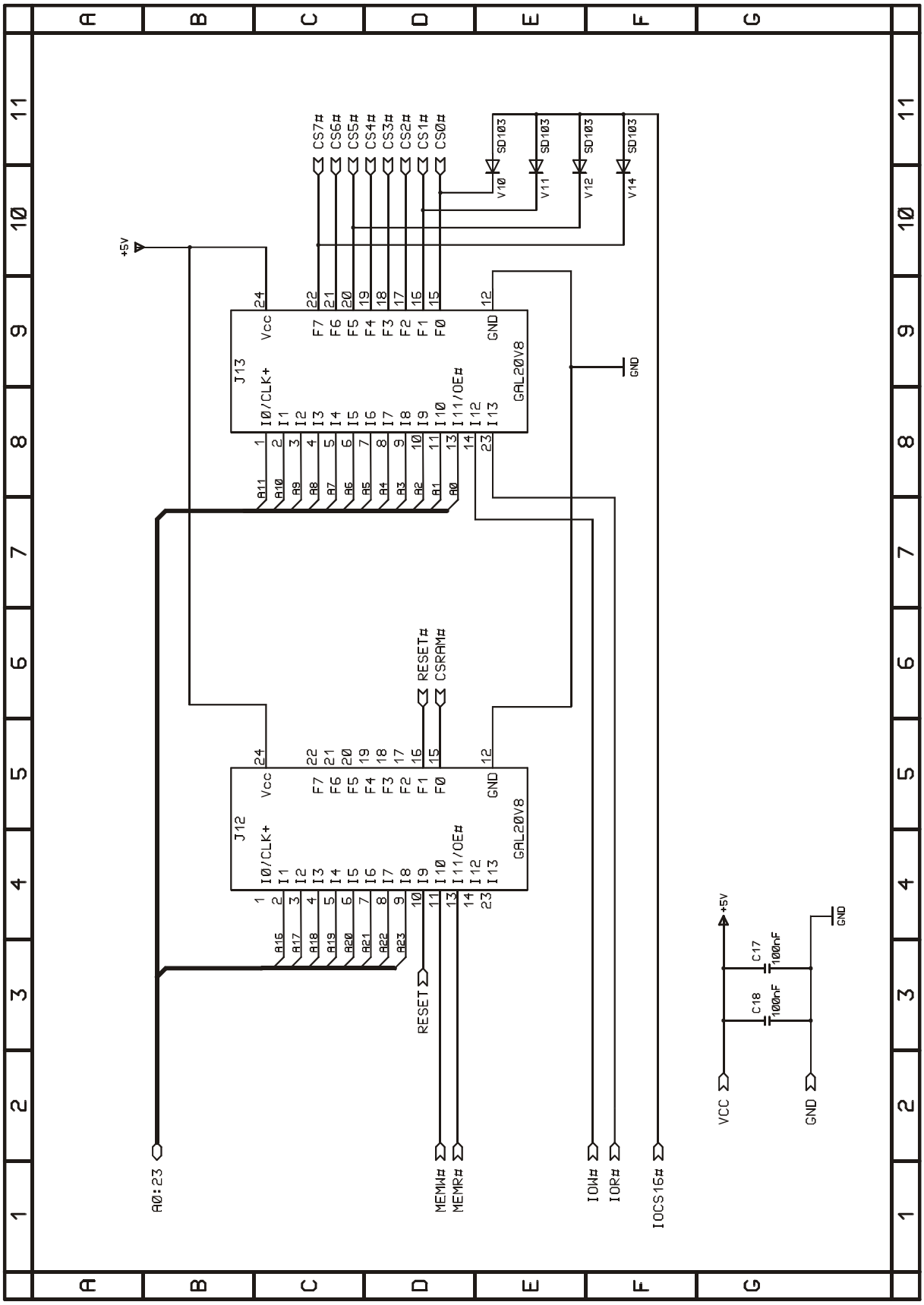
CS7#
CS6#
CS5#
CS4#
CS3#
CS2#
CS1#
CS0#
SD103
V10
V11
V12
V14
+5V
J13
GAL20V8
Vcc
GND
I0/CLK+
I11/OE#
J12
RESET#
CSRAM1#
RESET
A0:23
MEMW#
MEMR#
IOW#
IOR#
IOCS16#
C17
C18
100nF
VCC

Figure 17

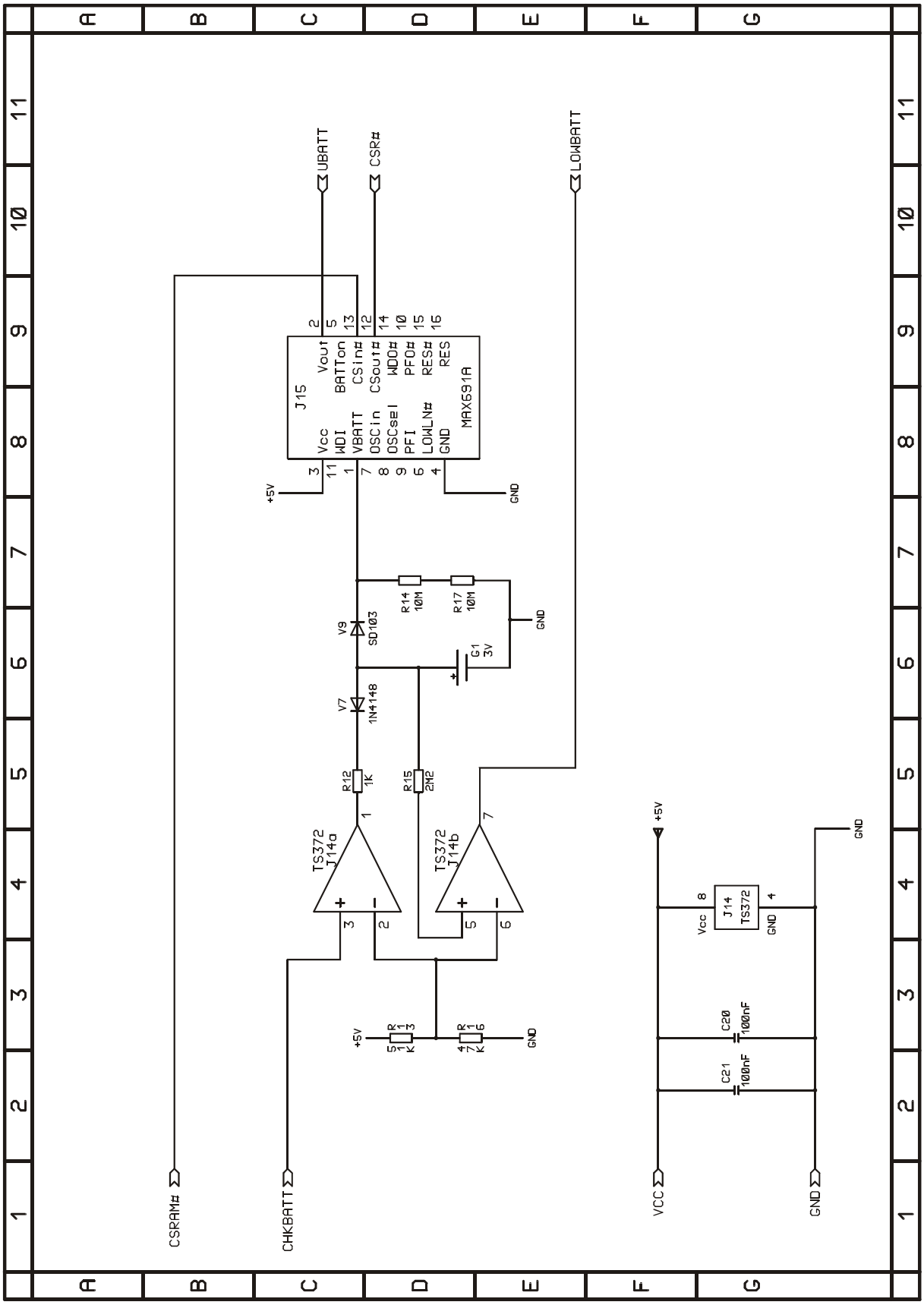
UBATT
CSR#
LOWBATT
J15
MAX691A
Vout
BATTon
CSin#
CSout#
WDO#
PFO#
RES#
RES
Vcc
WDI
VBATT
OSCin
OSCsel
PFI
LOWLN#
GND
+5V
GND
R14 10M
R17 10M
V9 SD103
G1 3V
V7 1N4148
R12 1K
R15 2M2
TS372 J14a
TS372 J14b
R 11 K
R 47 K
C20 100nF
C21 100nF
J14 TS372
CSRAM#
CHKBATT
VCC
GND

Figure 18

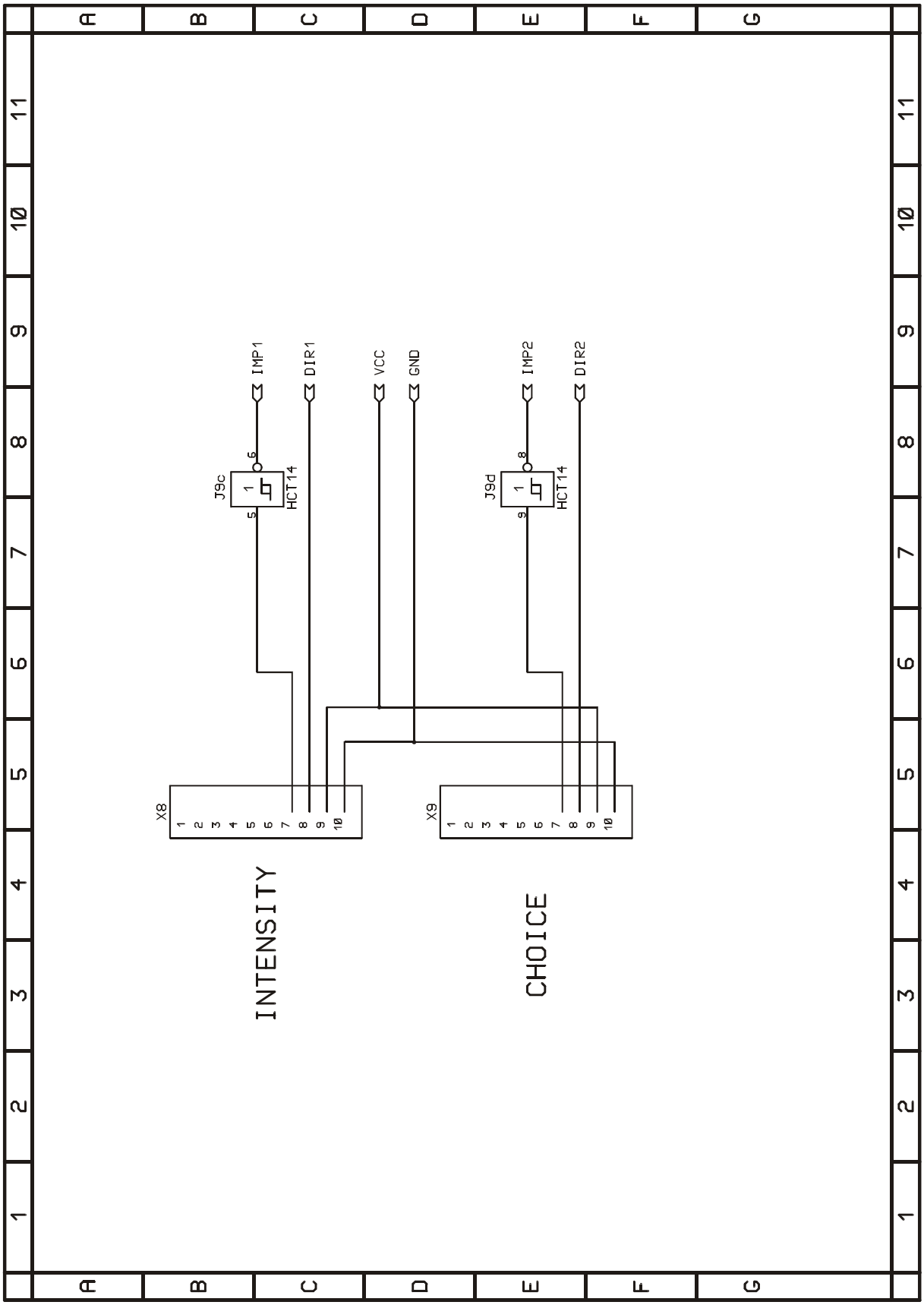
A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
9
10
11
IMP1
DIR1
VCC
GND
IMP2
DIR2
J9c
J9d
HCT14
X8
X9
INTENSITY
CHOICE

Figure 19

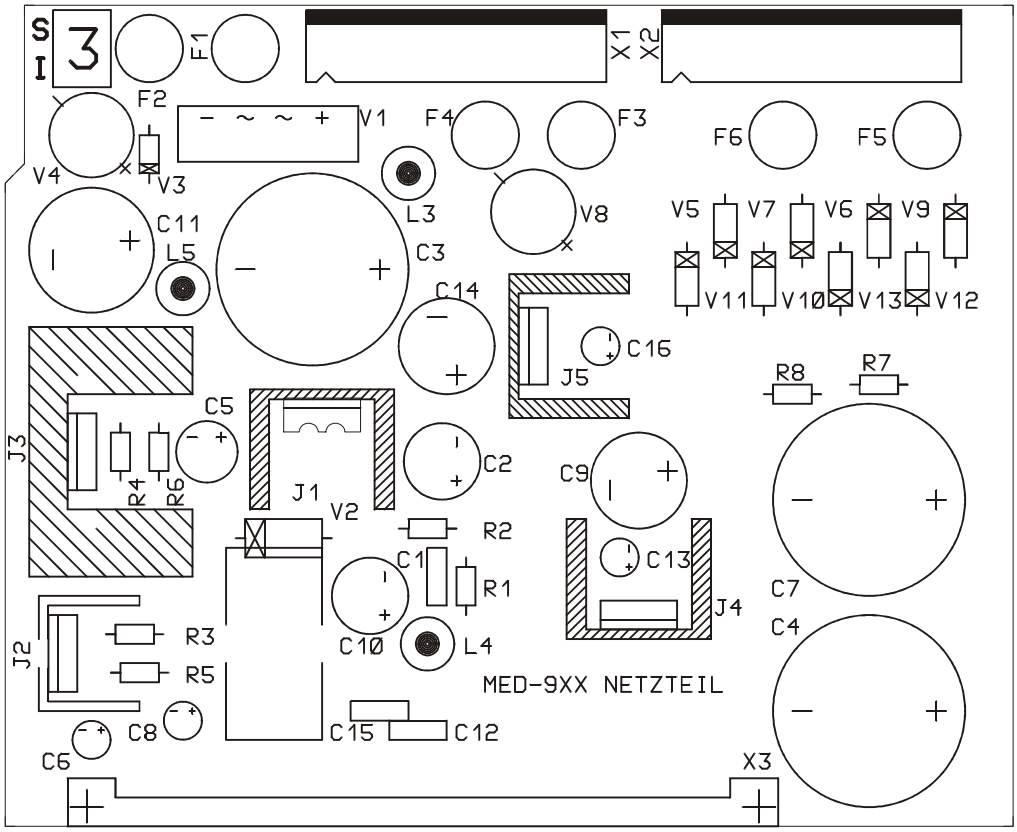
S
I
3
F1
F2
V1
F4
F3
F6
F5
X1
X2
V4
V3
L3
V8
V5
V7
V6
V9
C11
L5
C3
V11
V10
V13
V12
C14
C16
J5
R8
R7
C5
J3
R4
R6
J1
C2
C9
V2
R2
C1
R1
C13
C7
J4
C4
R3
C10
L4
J2
R5
MED-9XX NETZTEIL
C8
C15
C12
C6
X3

Figure 20

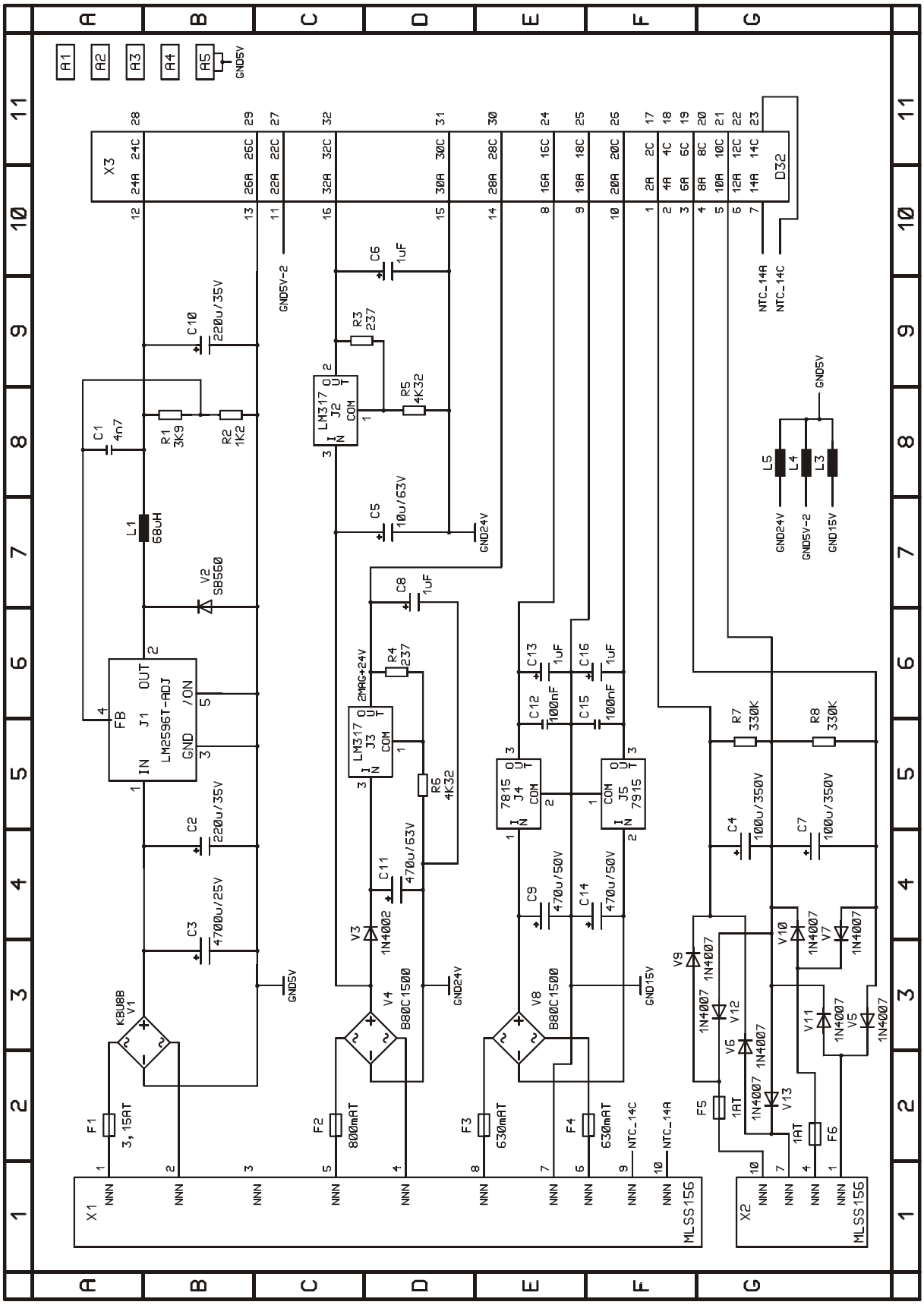
A1
A2
A3
A4
A5
GND5V
X3
D32
NTC_14A
NTC_14C
C10
220u/35V
C1
4n7
R1
3K9
R2
1K2
L1
68uH
V2
SB560
C2
220u/35V
C3
4700u/25V
GND5V
LM2596T-ADJ
FB
J1
OUT
/ON
GND
IN
KBU8B
V1
F1
3,15AT
X1
MLS156
GND5V-2
C6
1uF
R3
237
LM317
J2
R5
4K32
C5
10u/63V
GND24V
C8
1uF
R4
237
2MAG+24V
LM317
J3
R6
4K32
C11
470u/63V
V3
1N4002
V4
B80C1500
F2
800mAT
GND24V
7815
J4
C9
470u/50V
C14
470u/50V
V8
B80C1500
F3
630mAT
F4
630mAT
GND15V
NTC_14C
NTC_14A
C13
1uF
C12
100nF
C15
100nF
C16
1uF
7915
J5
R7
330K
R8
330K
C4
100u/350V
C7
100u/350V
V9
1N4007
V10
1N4007
V7
1N4007
V12
1N4007
V6
1N4007
V13
1N4007
V11
1N4007
V5
1N4007
F5
1AT
F6
1AT
X2
MLS156
L5
L4
L3
GND24V
GND5V-2
GND15V
GND5V

Figure 21

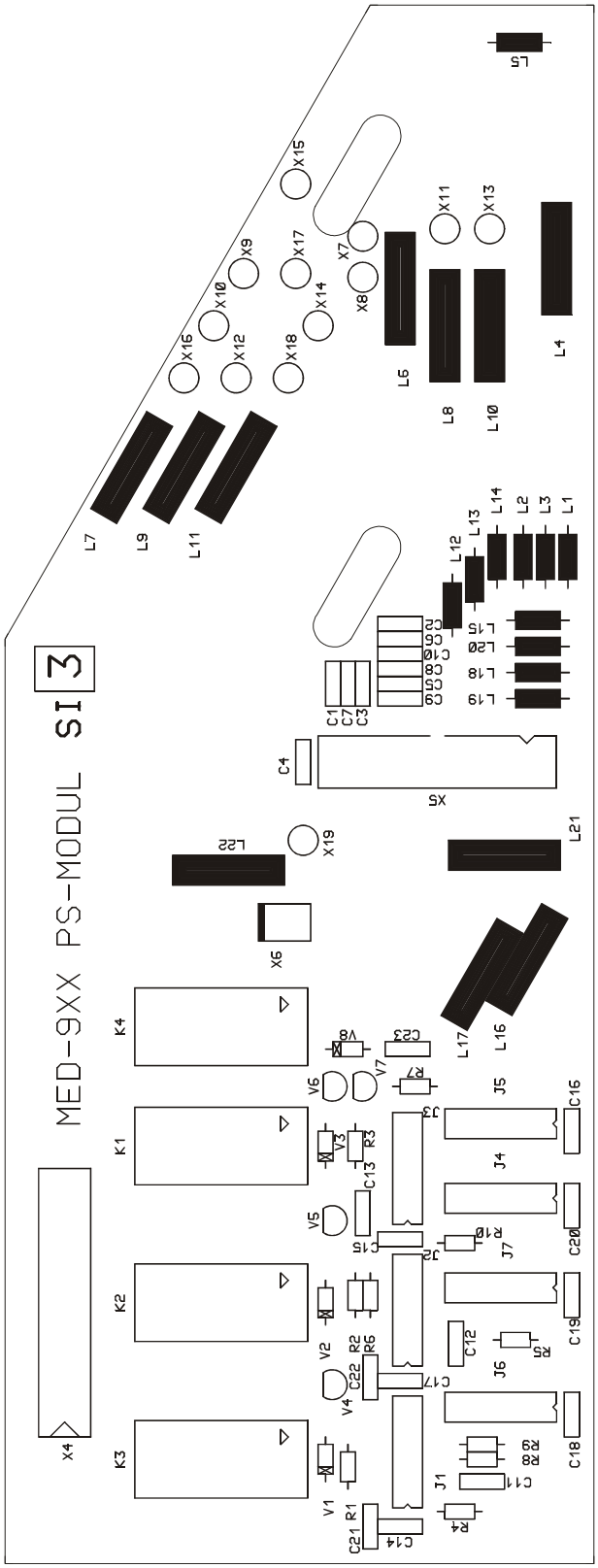
MED-9XX PS-MODUL SI 3
L5
X15
X11
X13
X9
X17
X7
X10
X14
X8
X16
X12
X18
L6
L8
L10
L4
L7
L9
L11
L14
L13
L2
L3
L1
L12
L15
L20
L18
L19
C2
C6
C10
C8
C5
C9
C1
C7
C3
C4
X5
L22
X19
L21
X6
K4
K1
K2
K3
X4
V8
C23
V6
V7
R7
J5
J3
C16
V3
R3
C13
J4
V5
C15
R10
J7
J2
C20
V2
R2
R6
C12
R5
C19
J6
C17
V4
C22
R8
R9
C18
J1
C11
V1
R1
C21
C14
R4
L17
L16

Figure 22

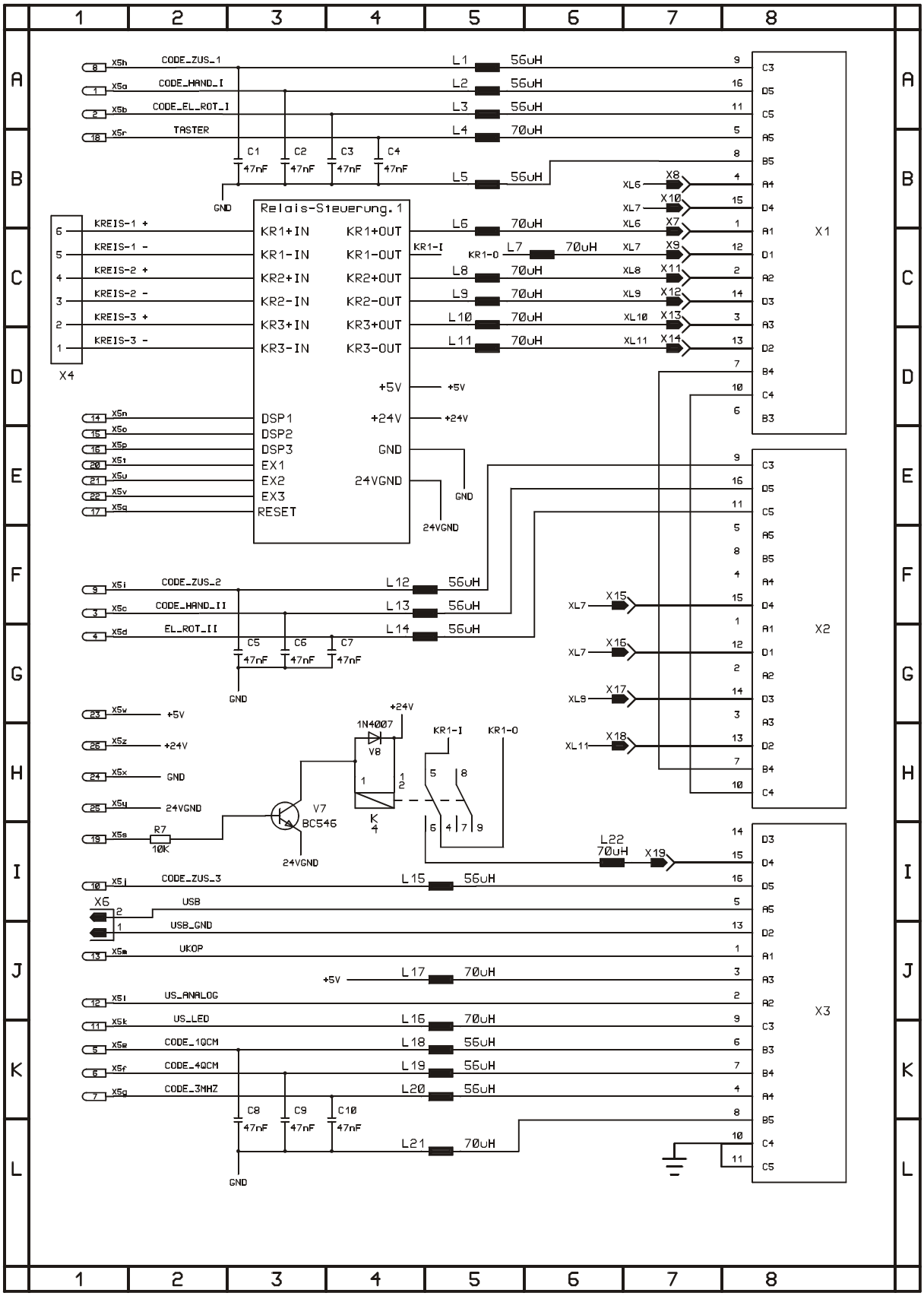
Relais-Steuerung.1
KREIS-1 +
KREIS-1 -
KREIS-2 +
KREIS-2 -
KREIS-3 +
KREIS-3 -
KR1+IN
KR1-IN
KR2+IN
KR2-IN
KR3+IN
KR3-IN
KR1+OUT
KR1-OUT
KR2+OUT
KR2-OUT
KR3+OUT
KR3-OUT
+5V
+24V
GND
24VGND
DSP1
DSP2
DSP3
EX1
EX2
EX3
RESET
CODE_ZUS_1
CODE_HAND_I
CODE_EL_ROT_I
TASTER
CODE_ZUS_2
CODE_HAND_II
EL_ROT_II
CODE_ZUS_3
USB
USB_GND
UKOP
US_ANALOG
US_LED
CODE_10CM
CODE_40CM
CODE_3MHZ
1N4007
V7
BC546
R7
10K
L1 56uH
L2 56uH
L3 56uH
L4 70uH
L5 56uH
L6 70uH
L7 70uH
L8 70uH
L9 70uH
L10 70uH
L11 70uH
L12 56uH
L13 56uH
L14 56uH
L15 56uH
L16 70uH
L17 70uH
L18 56uH
L19 56uH
L20 56uH
L21 70uH
L22 70uH
C1 47nF
C2 47nF
C3 47nF
C4 47nF
C5 47nF
C6 47nF
C7 47nF
C8 47nF
C9 47nF
C10 47nF
X1
X2
X3
X4
X6

Figure 23

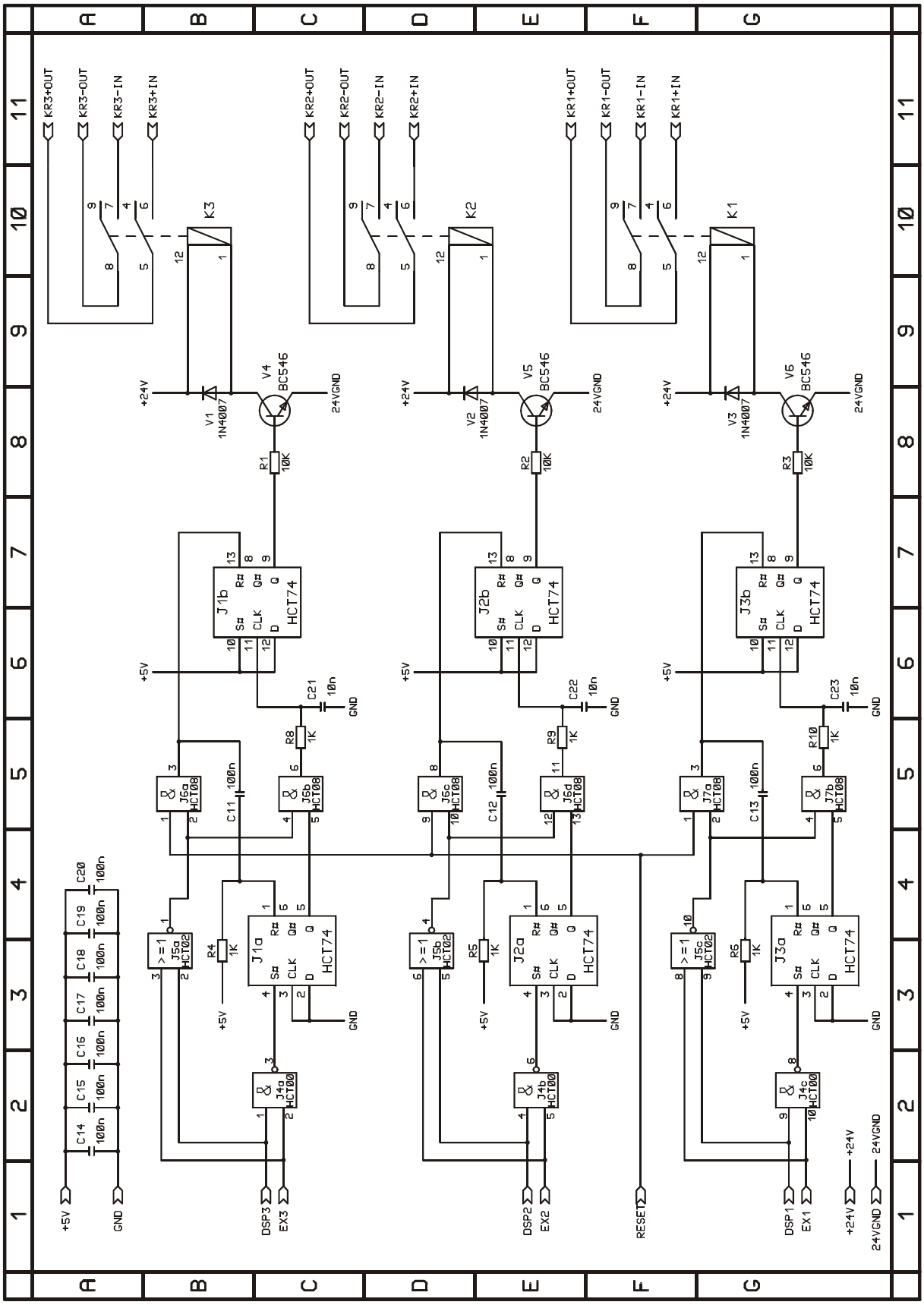
KR3+OUT
KR3-OUT
KR3-IN
KR3+IN
KR2+OUT
KR2-OUT
KR2-IN
KR2+IN
KR1+OUT
KR1-OUT
KR1-IN
KR1+IN
K3
K2
K1
+24V
24VGND
V1 1N4007
V2 1N4007
V3 1N4007
V4 BC546
V5 BC546
V6 BC546
R1 10K
R2 10K
R3 10K
J1b HCT74
J2b HCT74
J3b HCT74
+5V
GND
C21 10n
C22 10n
C23 10n
R8 1K
R9 1K
R10 1K
J6a HCT08
J6b HCT08
J6c HCT08
J6d HCT08
J7a HCT08
J7b HCT08
C11 100n
C12 100n
C13 100n
J1a HCT74
J2a HCT74
J3a HCT74
R4 1K
R5 1K
R6 1K
J5a HCT02
J5b HCT02
J5c HCT02
J4a HCT00
J4b HCT00
J4c HCT00
C14 100n
C15 100n
C16 100n
C17 100n
C18 100n
C19 100n
C20 100n
DSP3
EX3
DSP2
EX2
DSP1
EX1
RESET

Figure 24

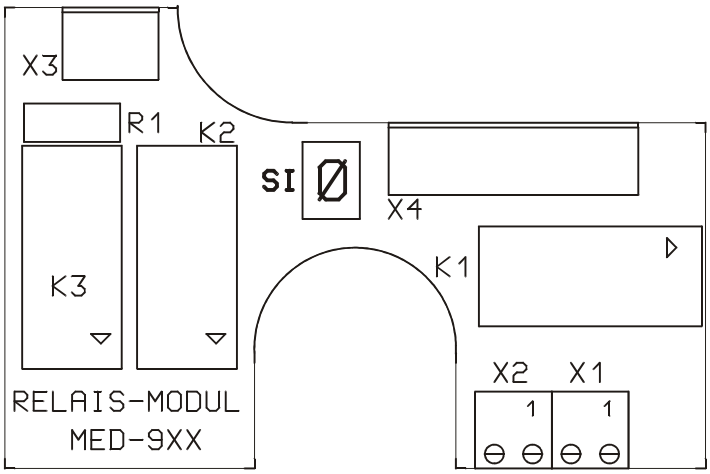

Figure 25

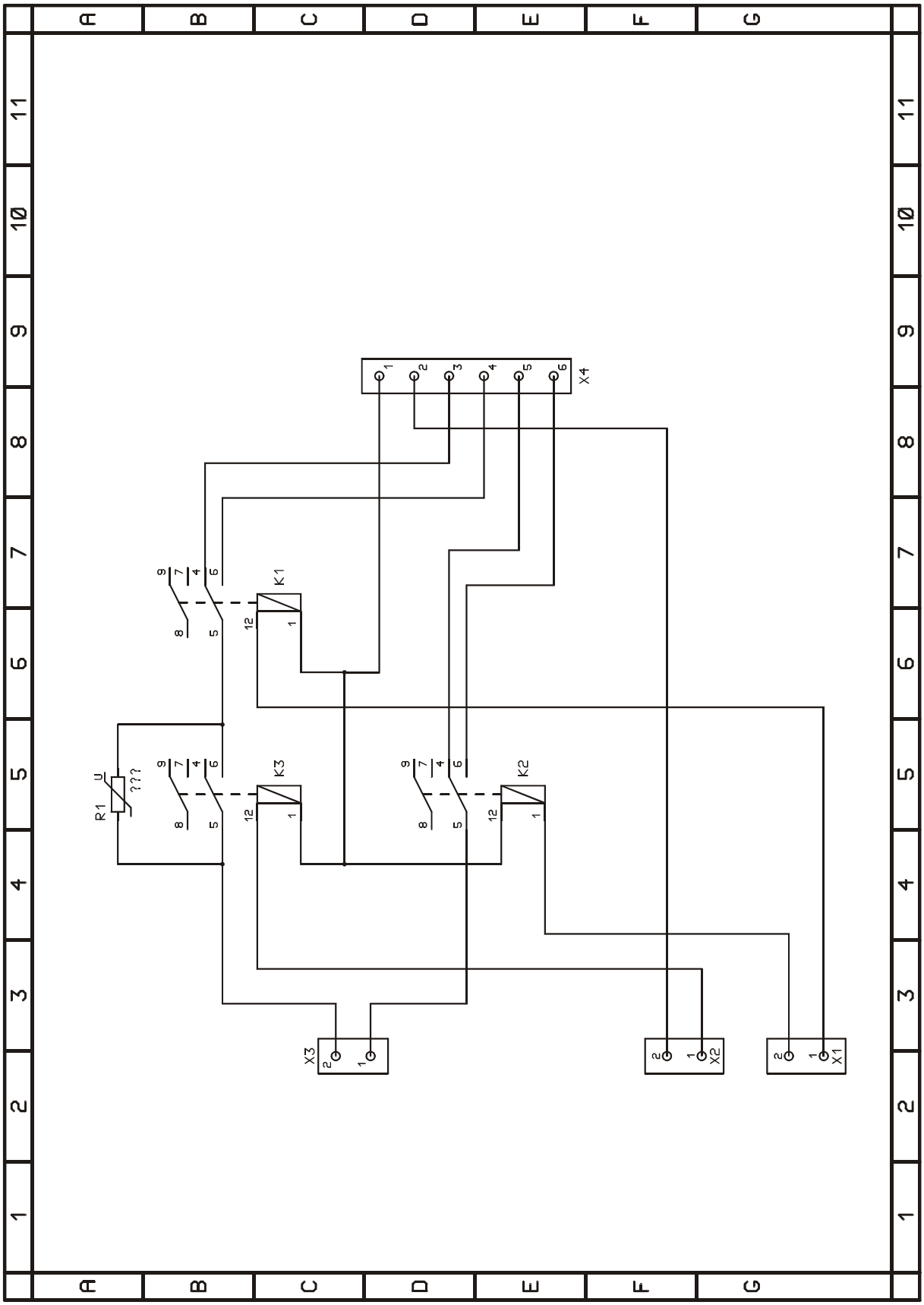

Figure 26

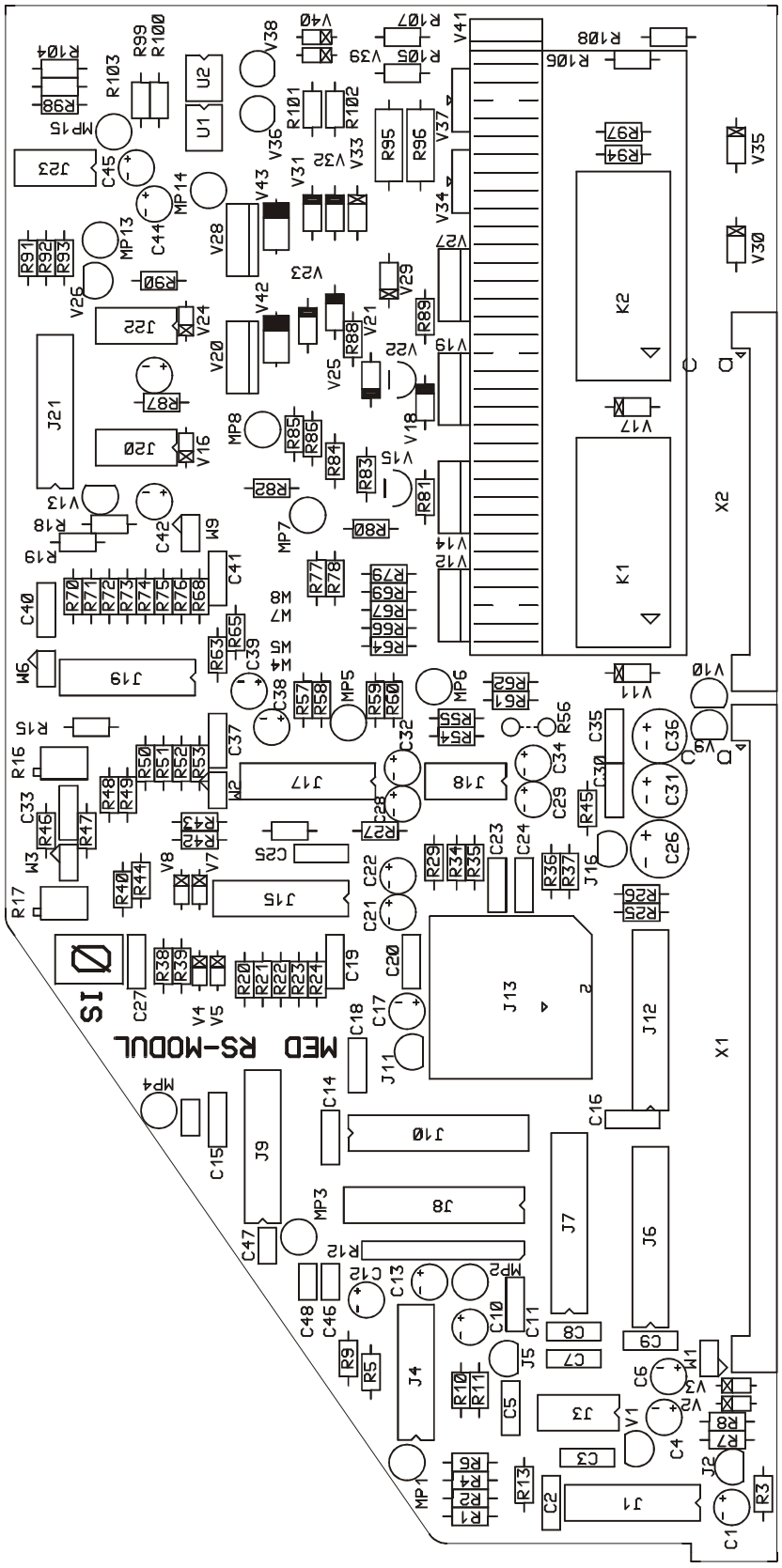
MED RS-MODUL
IS
X1
X2
K1
K2
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J15
J16
J17
J18
J19
J20
J21
J22
J23
U1
U2

Figure 27

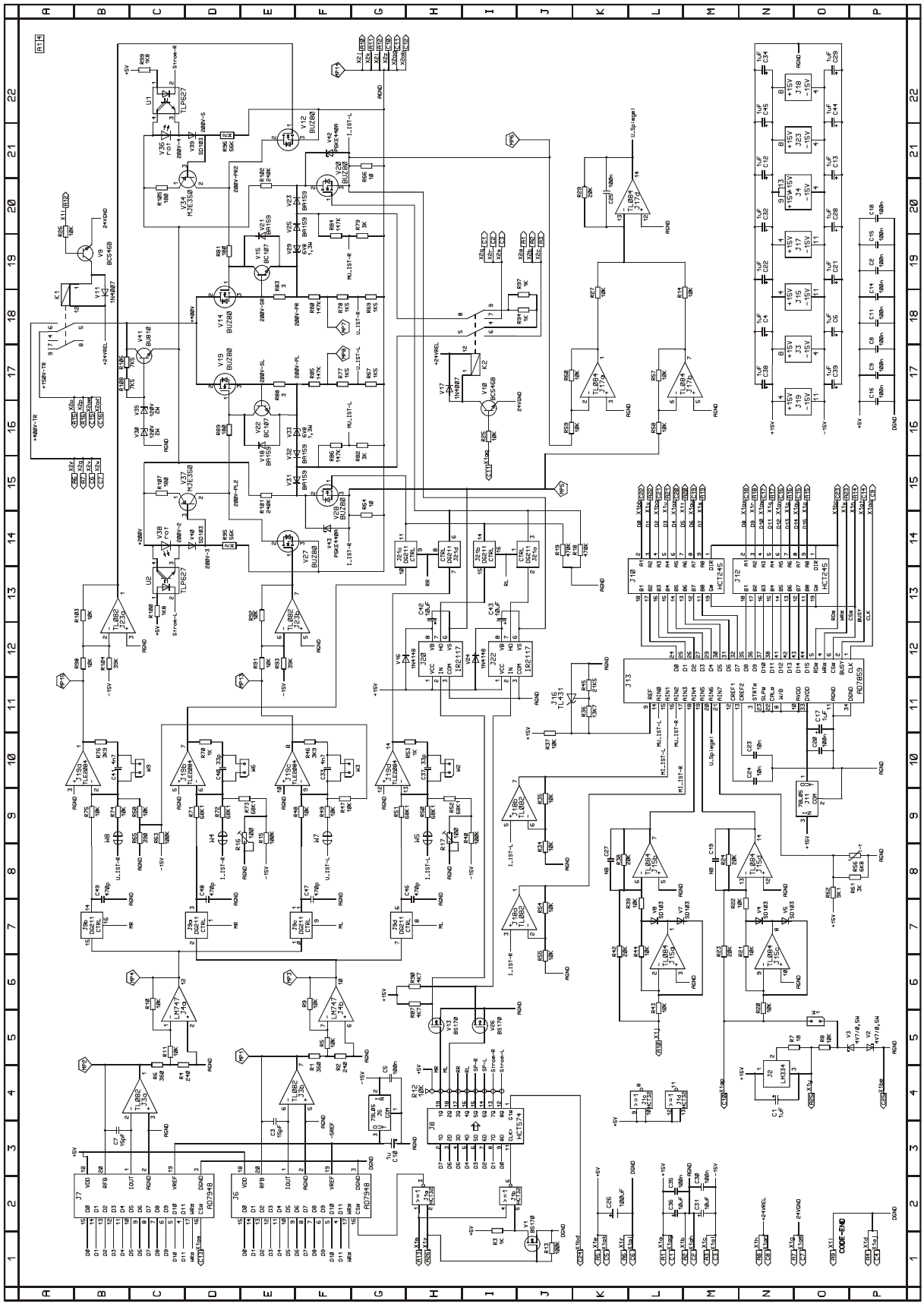

Figure 28

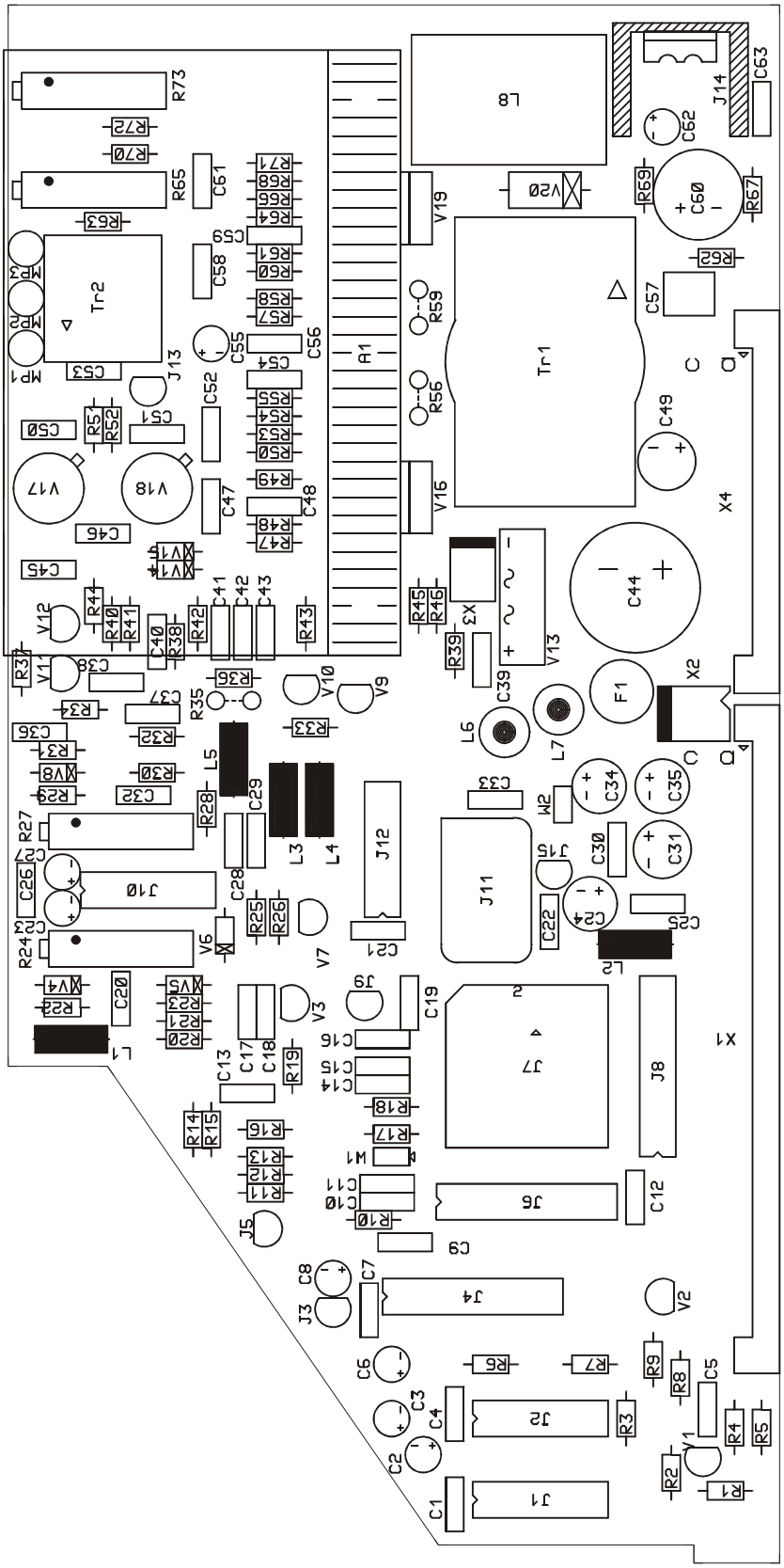

Figure 29

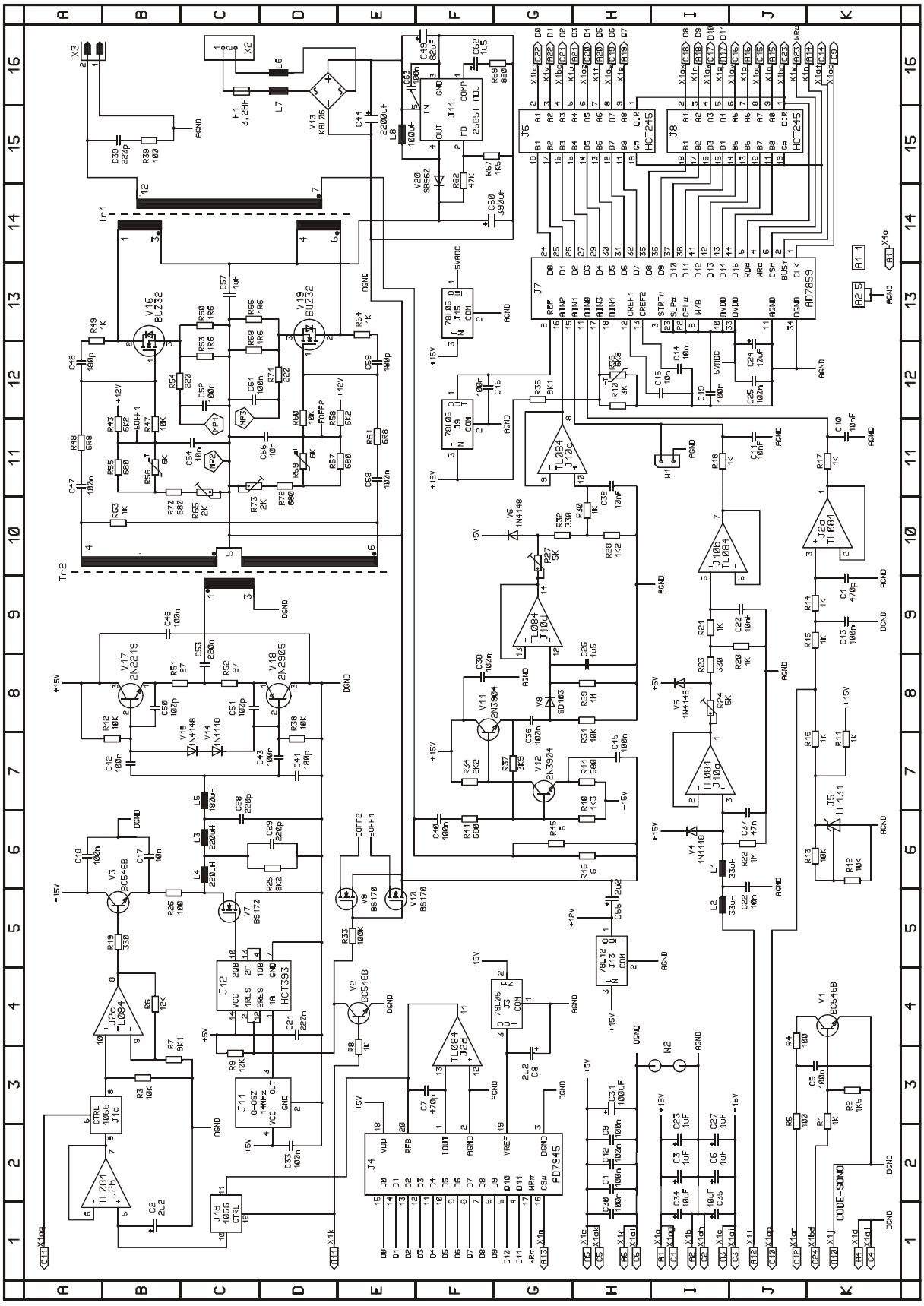

Figure 30

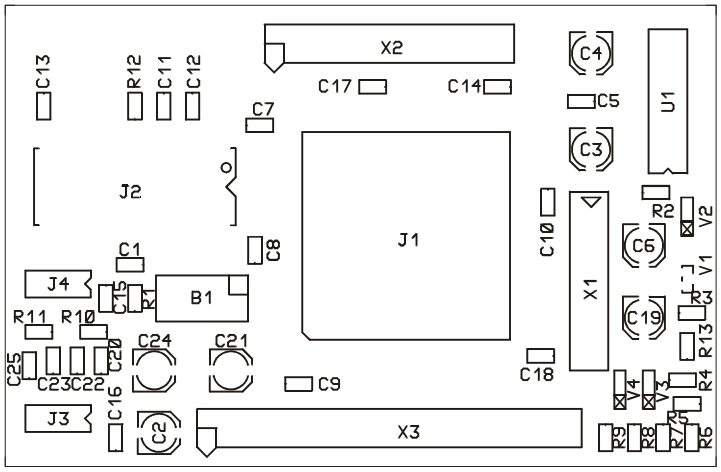
X2
C13
R12
C11
C12
C17
C14
C7
C4
C5
U1
C3
J2
J1
C10
X1
R2
V2
C6
V1
C1
C8
J4
B1
C15
R1
R11
R10
C24
C21
C19
R13
C25
C20
C18
C23
C22
C9
V4
V3
R4
J3
C16
C2
X3
R3
R8
R7
R5

Figure 31

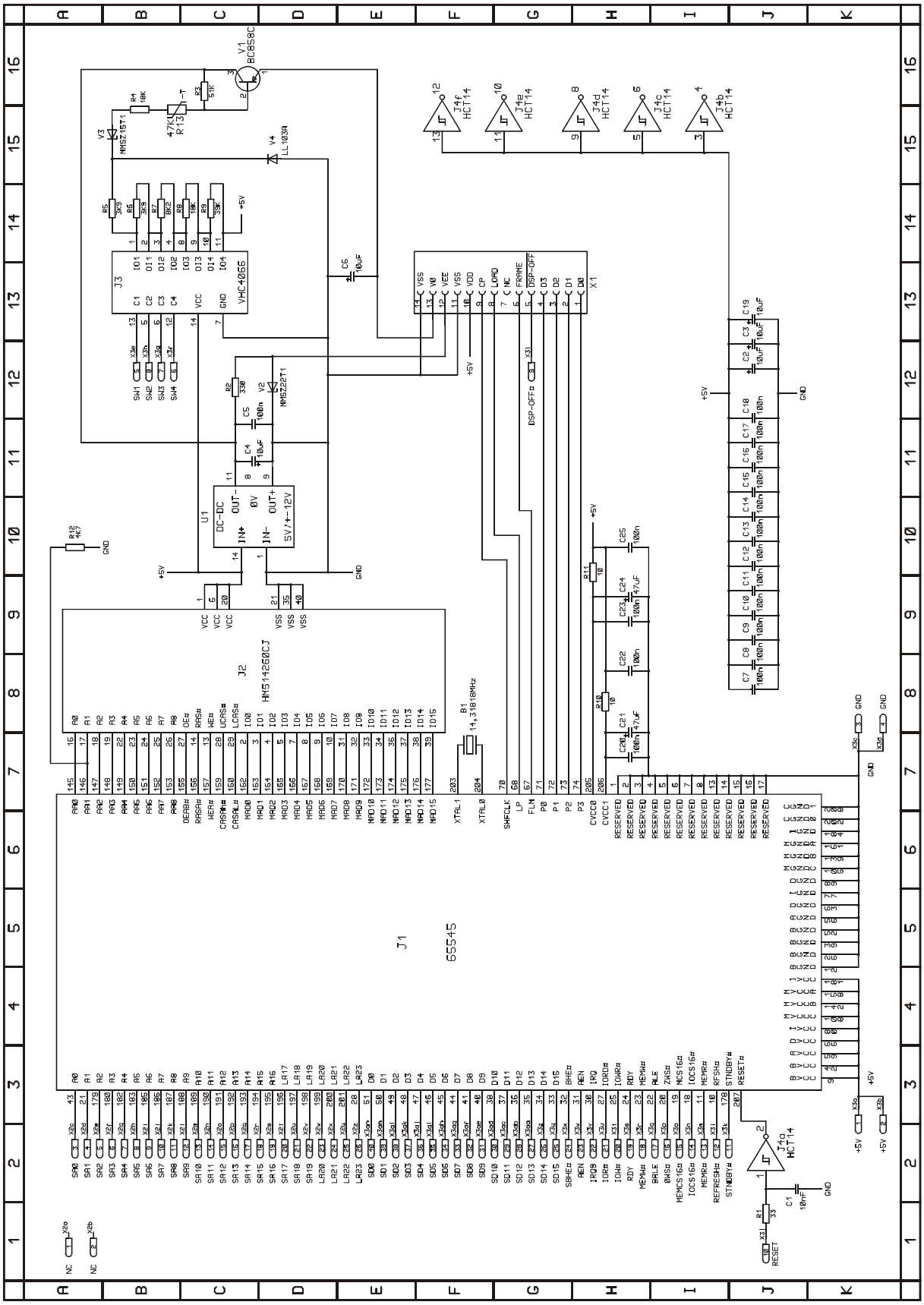

Figure 32

Correction sheet

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Please work on the faults and/or suggestions to present documentation:

Page	**Line**	**Faulty text**	**Correct text**

(If needed, please attach an additional sheet.)

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